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NATIONAL DAM INSPECTION PROGRAM. HAMBURG DAM AND RESERVOIR (PA---ETC(U)
SEP 78 J H FREDERICK, W S GARDNER DACW31-78-C-0048

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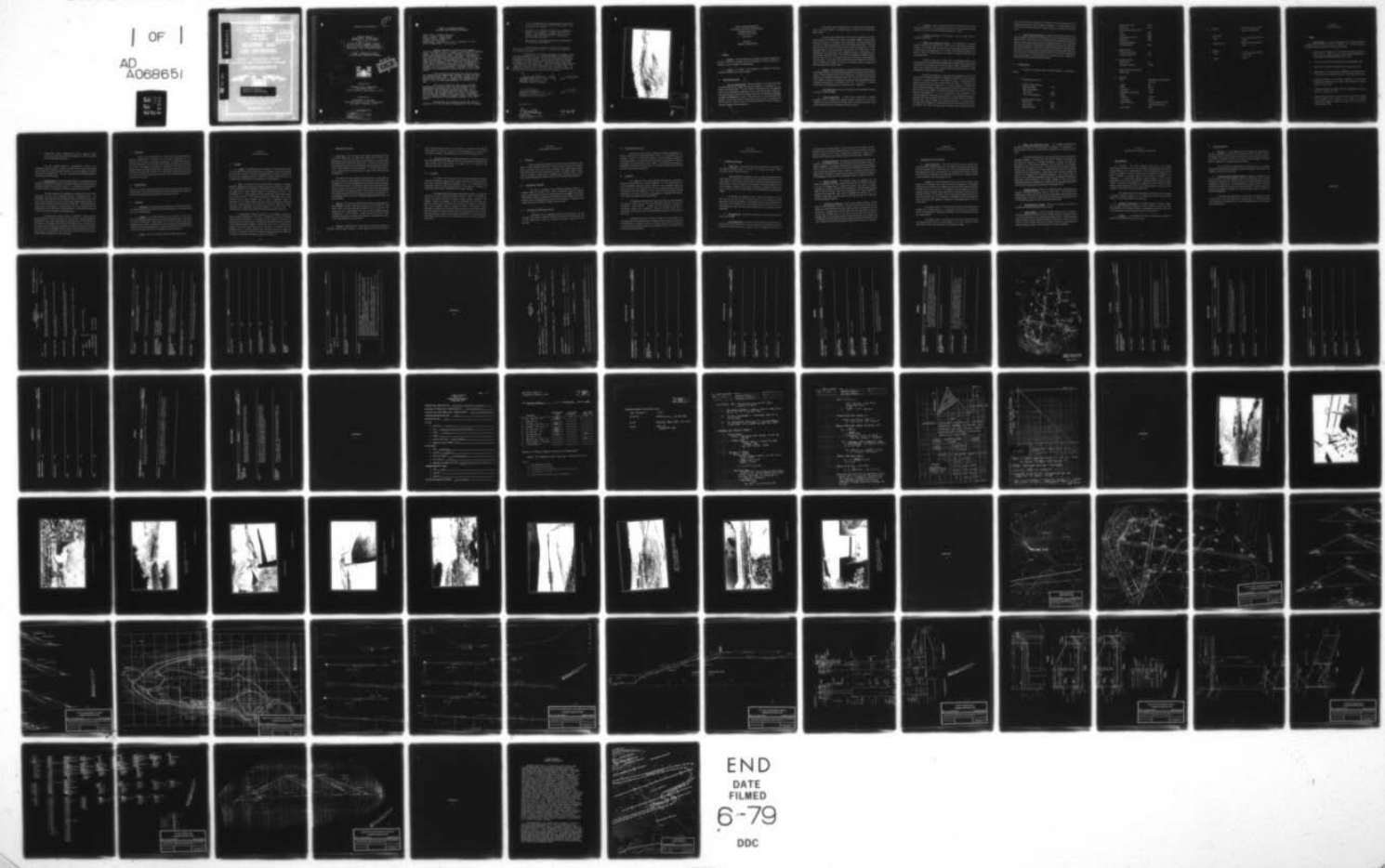

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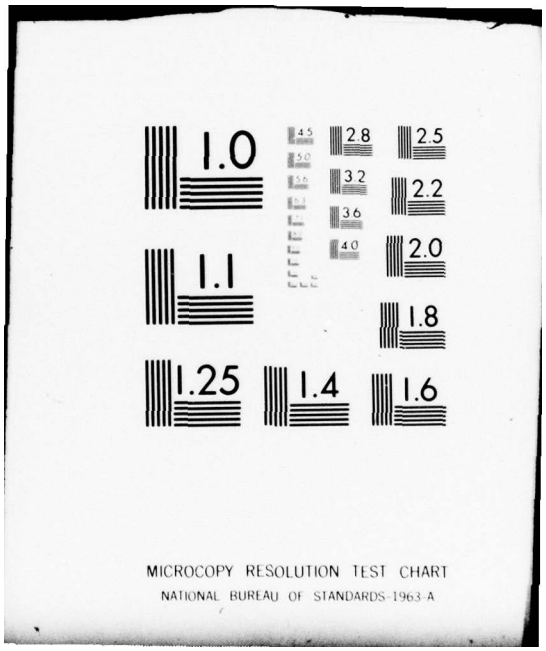
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HAMBURG DAM AND RESERVOIR

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

ORIGINAL CONTAINED COLOR PLATES; ALL DDC REPRODUCTIONS WILL BE IN BLACK AND WHITE

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

SEPTEMBER 1978

SCHUYLKILL RIVER BASIN

HAMBURG RESERVOIR
BERKS COUNTY, PENNSYLVANIA
NATIONAL I.D. NO. PA 00718

(6) National Dam Inspection Program. Hamburg Dam and Reservoir (PA-00718), Schuylkill River Basin, Furnace Creek, Berks County, Pennsylvania. Phase I Inspection Report,

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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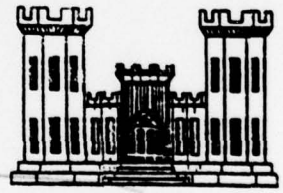

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Submitted to:

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

(11) September 1978

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

Name of Dam: Hamburg Reservoir
County Located: Berks County
State Located: Pennsylvania
Stream: Furnace Creek
Coordinates: Latitude 40° 35.1' Longitude 75° 56.5'
Date of INspection: 18 July 1978

Hamburg Reservoir is owned by the Hamburg Municipal Authority and is located in Berks County, Pennsylvania. The dam is used to supply water to the City of Hamburg and surrounding areas. The dam is considered to be in good condition and well maintained. The dam and reservoir were designed by Glace and Glace, Inc. of Harrisburg, Pennsylvania. The embankment and reservoir were completed in November, 1963. The dam is classified as a "High" hazard structure consistent with its potential in the event of failure for extensive property damage and possible loss of life downstream. The dam is also classified as an "Intermediate" size dam based on its 53 foot height.

Calculations indicate that the existing spillway systems are not adequately designed to pass the probable maximum flood (PMF). The spillway capacity at the present crest elevation is judged to be "Inadequate" in that it will only pass approximately 79 percent of the PMF.

The visual inspection and review of design documentation indicates that the dam, foundation and appurtenant structures are in good condition. It is noted that, due to complex geotechnical conditions in the valley, the dam was founded on valley fill deposits and the dam and reservoir were lined with a Pos-o-Pac liner to minimize reservoir seepage losses. Some seepage was noted downstream as discussed in Section 6 of this report.

Considering the condition of the dam and the seepage noted, the following recommendations are presented.

1. It is recommended that the seepage areas downstream of the dam be regraded and drained into the downstream creek.

2. Seepage as discussed in Section 7.2 should be monitored for changes in flow rates or turbidity. Any change in seepage rates or turbidity should be assessed by a registered professional engineer.

3. The crest of the dam should be re-established to the design elevation.

Consideration should be given to increasing the height of the spillway walls to enable the spillway to pass the PMF storm.

Because of the downstream water treatment facility and populated areas, a formal procedure of observation and warning during periods of high precipitation should be developed and implemented. This procedure should include a method of warning downstream residents that high flows are expected along the creek. The Owner should also develop a maintenance and inspection checklist to insure that all items are inspected and maintained on a regular basis. An alternate access route to the dam should be established so the dam can be monitored during severe storms.

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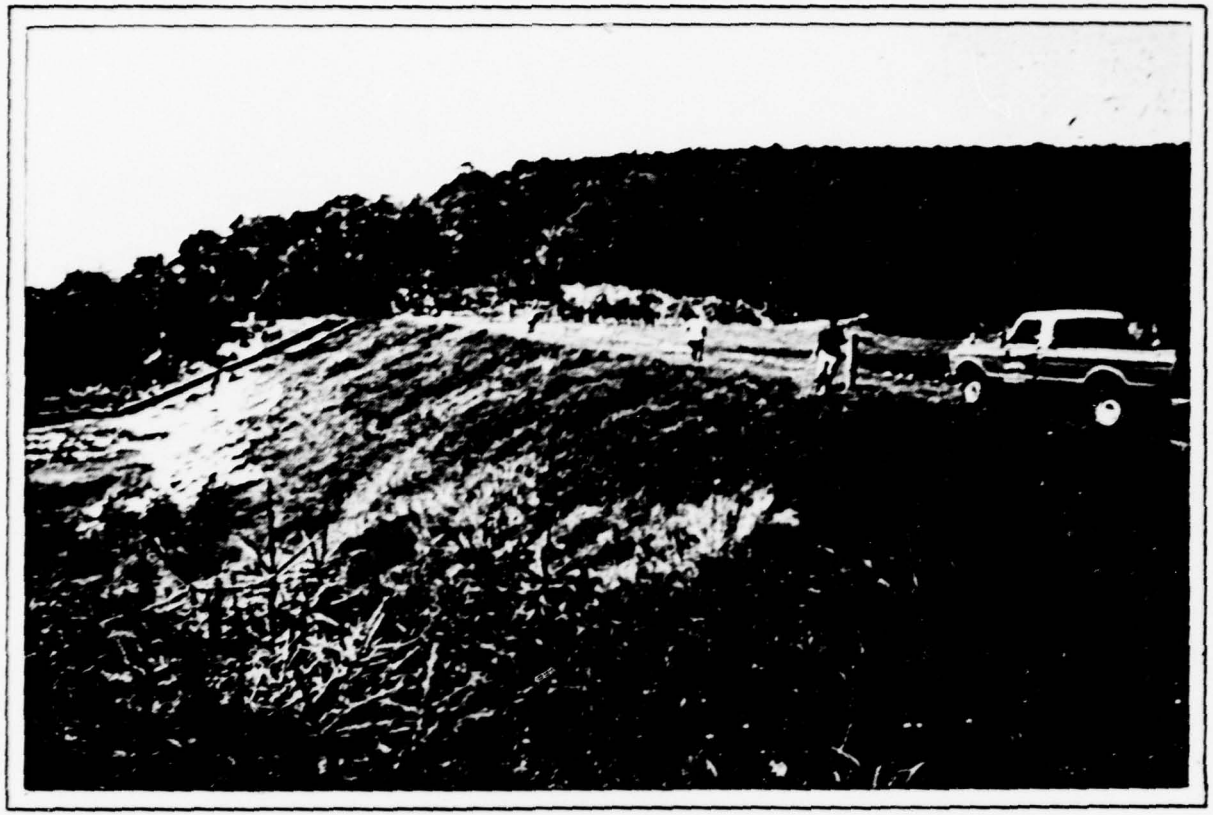
APPROVED BY:

28 Sep 78

C. K. WITHERS Date
Colonel, Corps of Engineers
District Engineer



OVERVIEW
HAMBURG DAM, BERKS COUNTY, PENNSYLVANIA

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
HAMBURG RESERVOIR
NATIONAL ID #PA 00718
DER #6-450

SECTION 1
PROJECT INFORMATION

1.1 General.

a. Authority. The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose. The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

ABSTRACT

PLUS OR MINUS 500

a. Dam and Appurtenances. Hamburg Reservoir is a 53-foot high rolled earth embankment which is 500± feet long and impounds a 7-acre reservoir in a 1.5 square mile drainage basin. The dam contains a downstream rock toe separated from the main homogeneous embankment by two 18-inch filter courses. Because of the unusual geologic conditions, the upstream portion of the embankment~~, as shown on Plate 3 of Appendix E,~~ contains a Pos-o-Pac liner to minimize embankment seepage. The dam does not have a cutoff trench or grout curtain. The reservoir has been lined with a 24-inch layer of Pos-o-Pac materials to minimize reservoir seepage losses (see Plate 4, Appendix E).

ABSTRACT

The upstream slope is protected with an 18-inch layer of dumped riprap over a 9-inch filter blanket. The upstream slope is 2.5H:1V and the downstream slope is 2.0H:1V.

The water supply intake tower has two inlets, at elevations 945 and 935, and is located at the upstream toe. Water is discharged through a common eight-inch cast iron pipe to a treatment plant downstream. The water supplies the residents of Hamburg, Pennsylvania, and the surrounding community. The pond drain located at the base of the tower has the intake at elevation 921.0. Water discharges through a 30-inch reinforced concrete pipe into a stilling basin at the downstream toe. Normal pool level is regulated by means of the spillway at the right abutment (elevation 952.0). The 30-foot wide spillway discharges through a 130-foot long chute with a 31.2 percent slope into a stilling basin at the downstream toe of the dam. The minimum flow requirement from the reservoir into Furnace Creek is 0.225 feet per second. This flow is maintained by means of a piped spring which discharges into the impact basin.

b. Location. Hamburg Reservoir was constructed across Furnace Creek at a point approximately 3.25 miles above the confluence of Furnace Creek and Maiden Creek, in Windsor Township, Berks County, Pennsylvania. The dam and reservoir are located 3 miles northeast of Hamburg, Pennsylvania and 1.5 miles north of William Penn Highway. The dam site and reservoir are shown on USGS Quandrangle entitled, "Hamburg, Pennsylvania", at coordinates N 40° 35.1' W 75° 56.5'. A regional location plan of Hamburg Reservoir is enclosed as Plate 1, Appendix E.

c. Size Classification. The dam is classified as an "Intermediate" size dam by virtue of its 53-foot height.

d. Hazard Classification. A "High" hazard classification is assigned consistent with the potential for extensive property damage and loss of life downstream along Furnace Creek and Maiden Creek. The flood plain along Furnace Creek contains several farms with barns containing livestock.

e. Ownership. The dam is owned by Hamburg Municipal Authority in Berks County, Pennsylvania. All correspondence should be sent to the Hamburg Municipal Authority, 31 North Third Street, Hamburg, Pennsylvania 19526.

f. Purpose of the Dam. The reservoir is used for water supply to Hamburg, Pennsylvania.

g. Design and Construction History. The application to construct Hamburg Reservoir was submitted on 6 April 1960 by the Hamburg Municipal Authority. The "Report Upon the Application of the Hamburg Municipal Authority of Berks County" was prepared on 15 July 1960 by the State of Pennsylvania. The permit to construct Hamburg Reservoir was issued by the State of Pennsylvania on 26 September 1960.

Construction began on 27 March 1960. Correspondence located in the Department of Environmental Resources (DER) files indicates that the early months of construction were plagued with construction/labor problems. Approximately four months after construction began, the labor problems were resolved and full scale operations were underway by late summer.

During the investigation, it was noted that the geology of the dam site was such that it would be economically unfeasible to excavate all of the unsuitable materials in the dam foundation. These materials consist of deep deposits of pervious talus and alluvial materials which filled in the valley. The extensive test boring programs disclosed the bedrock to be Tuscarora quartzite. However, the depth to rock was extremely variable, ranging from 10 feet on the right abutment to nearly 50 feet at the midpoint of the dam, and greater than 100 feet on the left abutment (see Appendix F). In lieu of excavating the entire foundation to the Tuscarora quartzite, the designer, Glace and Glace, Inc., Harrisburg, Pennsylvania, proposed that the dam and reservoir be lined with a suitable impervious material to minimize both reservoir leakage and foundation excavation. The three options considered were an asphalt liner, a Bentonite liner, and a Pos-o-Pac liner (a lime-fly ash mixture). The latter was chosen, and by November 1961, the Pos-o-Pac plant

was on line and ready for operation. By September 1962 and November 1962, the embankment and spillway were completed, respectively. Through November 1963, the Pos-o-Pac liner was placed, and the dam was officially completed in November 1963.

h. Normal Operating Procedures. Under normal operating conditions, the reservoir overflow is controlled by the spillway located at the right abutment (crest elevation 952.0). Water for the City of Hamburg is drawn off through the control tower by means of two intakes located at elevations 945 and 935. The intake pipes converge to a single 8-inch pipe through the embankment, down the valley and into a water treatment facility. The pond drain intake is at the base of the intake tower, controlled by a 30-inch sluice gate discharging through a 30-inch concrete pipe. The sluice gate valve is located atop the intake tower and the 30-inch pipe discharges into an impact basin at the downstream toe, as shown on Plate 2, Appendix E, entitled "Plan of Dam and Appurtenant Structures."

1.3 Pertinent Data.

A summary of pertinent data for Hamburg Reservoir is presented as follows.

a.	Drainage Area (sq. miles)	1.5
b.	Discharge at Dam Site (cfs)	
	Design High Water	1970
	Maximum Discharge (Elev. 959.5)	2340
	Minimum Flow Required	0.225
c.	Elevation (feet above MSL)	
	Normal Pool	952.0
	Spillway Crest	952.0
	Design High Water	958.7

Maximum Pool Level	959.5
Top of Dam	961.0
Intake Tower Entrance Inverts	
Top	945.0
Middle	935.0
Impact Basin Exit Invert	908.0
Pond Drain	921.0
Spillway Stilling Basin (top of end wall)	905.0

d. Reservoir (miles)

Length at Normal Pool	0.17
Fetch at Normal Pool	0.17

e. Storage (acre-feet)

Normal Pool	92
Maximum Flood Pool	145 est.

f. Reservoir Surface Area (acres)

Normal Pool	7

g. Dam Data

Type	Rolled earth with downstream rock toe
Length	500
Height	53 feet
Crest Width	12 feet
Freeboard at Normal Pool	9 feet
Slopes	
Upstream	2.5H:1V
Downstream	2.0H:1V
Special Provisions	Dam and reservoir are lined with a Pos-o-Pac liner.
Grout curtain	None

h.	Diversion	Diversion through a concrete pipe during construction.
i.	Outlet Works	
	Type	8-inch cast iron pipe for water supply.
	Reservoir Drain	30-inch reinforced concrete pipe.
j.	Spillway	
	Type	Concrete ogee weir and concrete chute.
	Width	30 feet

SECTION 2
ENGINEERING DATA

2.1 Design.

a. Data Available. A summary of engineering data on Hamburg Reservoir is presented on the checklist attached as Appendix A. Principal documents containing pertinent data used for this report are as follows.

1. "Report Upon the Application of the Hamburg Municipal Authority of Berks County", by Joseph J. Ellam, Hydraulic Engineer, Department of Environmental Resources (DER), dated 15 July 1960.

2. "Permit" to construct Hamburg Reservoir issued 26 September 1960.

3. "Application" to construct Hamburg Reservoir issued 6 April 1960.

4. "Specifications for Construction of Impounding Dam, Reservoir, and Transmission Line", by Glace and Glace, Inc., Harrisburg, Pennsylvania.

5. "Engineering Report to the Borough of Hamburg on the Proposed Hamburg Dam and Reservoir on Furnace Creek", prepared by Glace and Glace, Inc., August 1959.

6. "Preliminary Report", Borough of Hamburg, as prepared by Glace and Glace, Inc., dated March 1, 1955.

7. "Monthly Progress Reports, Construction of Earth Fill Dam, Reservoir and Transmission Line", prepared by Mr. Robert D. Rowland, Construction Manager for Glace and Glace, Inc., from April 1961 through February 1963.

8. Miscellaneous letters, correspondence, memos, inspection reports, construction reports and other data located in the DER main office files in Harrisburg, Pennsylvania.

The data available included a comprehensive summary of the embankment stability analysis. Included in the files were a series of boring logs, some concrete test results, and some Pos-o-Pac test results, together with several soils tests and strength tests. Structural calculations and hydrologic/hydraulic calculations were not available.

b. Design Features. The principal design features of the embankment and appurtenant structures are illustrated on the plan, profiles, and cross-section plates enclosed in Appendix E as Plates 2 through 11. A description of the features is discussed in Section 1.2, "Description of Project" and summarized as follows.

The earth embankment was designed as a homogeneous structure with a downstream rock toe and an upstream Pos-o-Pac anti-seepage liner. The embankment was constructed with an upstream slope of 2.5H:1V, protected by an 18-inch thick riprap layer over a 9-inch filter course. Beneath the filter course is a pervious section overlying a 3-foot layer of Pos-o-Pac liner. The downstream slope is 2H:1V and grass protected. The downstream rock toe is separated from the embankment by two 18-inch layers of filter materials. The dam has a crest width of 12 feet and is covered with grass. See Photograph No. 1.

The intake tower is shown on Plate 7, Appendix E. Water enters the tower through two 16-inch sluice gates into an 8-inch cast iron pipe, through the embankment to the water treatment plant approximately 1/2 mile downstream. Excess water is discharged over the spillway at the right abutment of the structure. The reservoir can be drawn down by opening the 30-inch sluice gate at the base of the tower. Water is discharged through a 30-inch precast concrete outlet into an impact basin at the downstream toe. Water from the pond drain and the spillway converge 250 feet downstream into Furnace Creek.

2.2 Construction.

Based on the documentation in the DER files and available design drawings, supplemented by discussions with the Owner's representative, it is concluded that the dam was constructed as designed. Available records indicate that Glace and Glace, Inc. of Harrisburg, Pennsylvania, were the prime designers, and the soils investigation and testing was performed by the Boring, Soils and Testing Company, Harrisburg, Pennsylvania. The general contractor for this work was the Tri-W Construction Company, Inc. Reports indicate that Glace and Glace, Inc. was the construction manager and submitted monthly reports documenting the month's activities to DER.

2.3 Operation Data.

There are no records maintained other than the quantity of water used through the treatment plant. Minimum flow requirements are maintained through the tower and out the 30-inch concrete pipe into the impact basin at the dam toe.

2.4 Evaluation.

a. Availability. All engineering data reproduced in this report and studied for this investigation were provided by DER and supplemented by conversations with the Owner's representatives.

b. Adequacy. The available design data was sufficient to evaluate this structure, although the design data did not include hydrologic/hydraulic calculations or structural calculations. Slope stability studies and soil testing results were available and of sufficient completeness to allow an evaluation of the embankment. Construction data consisted primarily of monthly progress reports submitted by the construction manager, Mr. Robert D. Rowland, of Glace and Glace, Inc.

c. Validity. There is no reason to question the validity of the data.

SECTION 3
VISUAL INSPECTION

3.1 Findings.

a. General. The observations and comments of the field inspection team are contained in the checklist enclosed herein as Appendix B, and are summarized and evaluated as follows. In general, the appearance of the facility indicates that the dam and its appurtenances were constructed in general accordance with the drawings, and are reasonably well maintained and in good condition.

b. Dam. During the visual survey, there were no indications or evidence observed of distortions in alignment or grade that would be indicative of movement of the embankment or the foundation. The upstream riprap was in good condition and stable with no signs of slope movement or distortions of the rock. See Photograph No. 1. The downstream slope is predominantly grass covered, stable, and in good condition. The junctions between the embankment and the left abutment were in good condition, with no signs of significant erosion or deterioration. The junction between the spillway and the right abutment of the dam was also in good condition, with only minor settlements which are normally associated with embankments constructed adjacent to a spillway wall. This settlement has not significantly reduced the flood storage capacity of the dam.

As delineated on Sheet 5a, Appendix B, some seepage was noted at several locations downstream of the dam. Considering the type of vegetation (cattails noted in the area), it is concluded that this seepage is steady and has existed for at least several years. Considering the foundation problems mentioned in the preliminary report prepared by Glace and Glace, Inc., it is expected that seepage of this nature would have occurred. However, is also appears that this seepage has been in a steady condition over many years, and that no changes are occurring. This judgment should be confirmed by seepage monitoring to determine if changes in rates of flow or changes in turbidity are occurring.

c. Appurtenant Structures.

1. Intake Tower. Since the water supply intakes, discharge conduit, and most of the intake riser are beneath the water level or buried in the embankment, only the top of the tower could be inspected. This also included the exercising of the three sluice gate valves. An inspection of the access bridge between the tower and the embankment was also performed and found to be in good condition and well maintained. The Armco valves were all partially exercised and all of them worked. They are clean, well maintained and lubricated.

The impact basin was inspected and observed to be in good condition. There were no signs of cracks, spalling, or deterioration of the concrete. See Photograph No. 3. During the inspection, it was noted that water was flowing from the 30-inch conduit. The caretaker reported that during construction a spring was located on the left side of the reservoir and a pipe was connected from the spring to the discharge conduit. The caretaker also indicated that most of the water coming from the conduit was coming from this spring. To his knowledge, there are no as-built drawings prepared describing where this pipe was placed.

2. Spillway. The spillway was inspected and found to be in good condition. See Photographs 5 and 6. There were no cracks in the weir section or in the spillway chute. The weep holes along the spillway were dry and clear. The stilling pool was in good condition and with no signs of spalling, concrete deterioration, or other cracking. There were several hairline cracks throughout the spillway, but these were assessed to be temperature cracks, and not associated with structural distress.

d. Reservoir. Reconnaissance of the reservoir disclosed no evidence of significant siltation, slope instability, or other features that would significantly

affect the flood storage capacity of the reservoir. The slopes are well vegetated and the edge of the reservoir is grass lined. See Photograph No. 8. A siltation pool was noted just upstream of the headwaters of the reservoir (Photograph No. 11).

e. Downstream Channel. Immediately downstream, the spillway and input basin discharges into Furnace Creek and thereafter flows through the valley past the water treatment plant and eventually into Maiden Creek. All slopes are well vegetated, stable, and in good condition.

3.2 Evaluation.

In summary, the visual survey of the dam and appurtenant facilities disclosed no evidence of apparent past or present movements with the exception of some slight settlement along the embankment crest. This settlement will not significantly affect the flood storage capacity of the reservoir. However, the embankment grade should be reestablished to the design elevation.

The seepage noted downstream, and delineated on Sheet 5a, is expected considering the sand and gravel foundation materials. There is no evidence to indicate an imminent potential for piping or slope instability because of this seepage. However, this seepage, as well as the seepage from the 30-inch pipe, should be monitored and the rates of flow measured and recorded to determine if there are any changes in rates or changes in turbidity. If the quantity should significantly increase or the flow become turbid, the condition should be studied in detail and necessary remedial measures taken. The exposed portions of the outlet works and pond drain systems were inspected and observed to be in good condition. The spillway was also found to be in good condition with no signs of significant deterioration.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures.

Normal operating procedures for this structure do not require a dam tender. The only regulation required is to vary the source of water from either the upper or the lower intake valve. Water is supplied to the treatment plant through the common 8-inch pipe which passes under the dam. Thereafter, water is fed by gravity to Hamburg. Excess water is discharged over the spillway into a stilling basin and to the downstream channel. There are no written operating procedures.

4.2 Maintenance of the Dam.

The dam is maintained by the Hamburg Municipal Authority. A caretaker checks the structure daily. Normal maintenance consists of cleaning slopes and checking the structure for deterioration and toe seepage. On occasion, the downstream seepage is checked by the caretaker for gross changes in flow rates. However, due to the vegetation and the extent of the seepage, it is judged that this inspection could only note drastic changes in the flow rates.

4.3 Maintenance of Operating Facilities.

Maintenance of the operating facilities is performed by the dam caretaker and consists of a regular cleaning and lubrication of the pond drain and the water supply valves. There are no official maintenance records kept for this structure.

4.4 Warning Systems in Effect.

There are no formal warning systems or procedures established to be followed during periods of exceedingly heavy rainfall. It is understood that the caretaker is always in the area and available to warn downstream residents of impending high flows. It is noted that the access bridge just downstream of the dam was washed out during Tropical Storm Agnes. An alternate route should be established to provide access to the dam for monitoring purposes during periods when the primary route is impassable.

4.5 Evaluation.

It is judged that the current operating procedures are sufficient to operate the simple facilities of Hamburg Reservoir. It is also concluded that the current maintenance procedures used are sufficient, as the caretaker inspects the dam at least once a day and checks the valves and other appurtenant structures. Commensurate with the possibility of loss of life and extreme property damage downstream in the event of failure or the passing of exceedingly high flows, a formal warning procedure should be implemented.

An operating procedure should also be formulated and implemented by the Owner to insure that the dam and appurtenant facilities are continually maintained in good condition. Coupled with this operational procedure, a maintenance manual and maintenance inspection checklist should also be formulated. The listing of items to be inspected should include all critical items of the facility.

Considering the dam's foundation materials and the seepage that is emanating from the downstream slope, a seepage monitoring procedure should also be implemented to monitor rates of flow. These rates should be compared to previous rates to determine if there are any changes occurring. The turbidity of the water should also be monitored.

SECTION 5
HYDROLOGY/HYDRAULICS

5.1 Evaluation of Features.

a. Design Data. Original design information was limited to statements in the Application Report, dated 15 July 1960. The designer was unable to supply hydrologic/hydraulic design information.

Hamburg Reservoir watershed is about 2.3 miles long and averages 0.7 miles wide, with a total area of 1.5 square miles. Elevations range from 1635 in the upper reaches to 952 at normal reservoir level. The slope of the watershed adjacent to the reservoir is about 25 percent. The watershed is 100 percent wooded and the entire watershed is owned by the Borough of Hamburg or reserved as State Game Lands. Therefore, the runoff characteristics of the watershed are not expected to change.

The spillway was designed to have a maximum discharge of not less than 1,965 cfs, the minimum value required by the "C" curve specified by DER (Department of Forests and Waters). In accordance with the criteria established by the Federal (OCE) Guidelines, the recommended spillway design flood for this "Intermediate" size dam and "High" hazard classification is the probable maximum flood (PMF).

b. Experience Data. No reservoir water level records or rainfall records for this dam are kept.

c. Visual Observations. On the date of the inspection, no conditions were observed that would indicate that the outlet capacity of the spillway would be reduced during a flood occurrence. As shown on Plate 2, Appendix E, the weir crest

is located about 35 feet downstream of the dam centerline. The height of the left spillway wall is 7.5 feet (Plate 9) above the weir crest (elev. 952), thus the maximum reservoir elevation is 959.5+ feet. Observations regarding the condition of the downstream channel, spillway conditions, and reservoir are located in Appendix B.

d. Overtopping Potential. This dam was not designed to pass the PMF, and therefore the overtopping potential was estimated from approximate methods as shown in Appendix C. Calculations indicate that the maximum spillway discharge is 2,340 cfs with the reservoir level at the minimum embankment elevation (959.5) while the estimated peak PMF inflow is 3,060 cfs. The available flood storage is approximately 53 acre-feet. These calculations indicate that the spillway walls will be overtopped by a PMF storm, but will pass approximately 79 percent of the PMF.

e. Spillway Adequacy. The spillway system is "Inadequate" but not "Seriously Inadequate" as the dam will pass more than 0.5 PMF without overtopping. If it can be demonstrated by raising the spillway walls and/or a detailed investigation of spillway discharge, that the spillway can discharge approximately 3,000 cfs, then the spillway rating would be "Adequate", as it would be capable of passing the estimated PMF storm without overtopping the spillway walls. The tailwater is estimated to be more than 35 feet below the dam with a maximum spillway discharge of 2,340 cfs.

f. Downstream Conditions. The first public highway bridge is located about 1.6 miles downstream of the dam. Between the dam and the bridge are two houses and a water treatment plant, which would be subject to damage in the event of failure. It is probable that if the dam failed, flow would separate, with a portion flowing down a parallel valley. In this case, one more home would be subject to damage. About 3.5 miles below the dam, Furnace Creek empties into Maiden Creek at Lenhartsville, where several more homes would be damaged with possible loss of life. Therefore, the "High" hazard potential classification for this dam is justified.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations. The visual observations did not indicate any existing embankment stability problems. The riprap on the upstream slope was quite stable and appeared to be in good condition. Similarly, the downstream slope and the vegetation were also in good condition. The embankment crest did not indicate that distortions or movement of the foundation were occurring. However, several inches of settlement were noted along the crest.

Seepage was noted downstream from the toe and in several areas adjacent to the embankment toe, as shown on Sheet 5a of Appendix B. This seepage is expected, but is currently not considered to be an indication of potential piping or imminent failure of the structure. This seepage, as well as seepage from the 30-inch pipe, should be carefully monitored because of the design of this structure, as described in Section 1 of this report. Since a comparison of seepage rates over the years has not been made, a firm assessment of the seepage could not be performed. Due to the extent of the seepage, an assessment of the seepage quantity could not be estimated.

The exposed portions of the pond drain facilities were inspected and assessed to be in good condition. It is reported by the Owner that the upstream section of the pond drain is periodically inspected by divers and that the trash racks are cleaned regularly.

The spillway system, including the weir, floor slab, and retaining walls, was inspected and found to be in good condition. Only minor cracking was noted consisting of hairline cracks associated with temperature changes.

b. Design and Construction Data. All available documentation, calculations and other data were reviewed and assessed for completeness. A detailed listing of this data is included herein as Appendix A and discussed in Section 2.

The design documentation for the embankment was, for the most part, considered complete. It is noted that there were no structural calculations, nor were there any hydraulic or hydrology calculations. However, the plans and specifications for the structural components were reviewed and are considered reasonable for this type of structure. The soil testing results and the stability analysis found in Department of Environmental Resources files were considered complete and quite comprehensive. Slope stability input values for cohesion and friction of the embankment are considered reasonable. The minimum factor of safety of 1.34 is considered reasonable for this type of embankment configuration. Construction reports prepared by the resident engineer of Glace and Glace, Incorporated were quite comprehensive, indicating that the dam and its appurtenant structures were constructed in accordance with the design criteria.

c. Operating Records. There are no operating records maintained for this structure other than consumption rates for water supply. The minimum flow requirement of 0.225 cubic feet per second is maintained through the pond drain discharge conduit. There are no high and low water level records maintained. There is no maintenance checklist or other maintenance records kept.

d. Post-Construction Changes. There are no reports nor is there any evidence that modifications were made to this dam.

e. Seismic Stability. The dam is located in Seismic Zone 1. Normally, it can be considered that if a dam in this zone is stable under static loading conditions, it can be assumed safe for any expected earthquake condition. The static stability analysis indicates that the steady state seepage condition has a minimum factor of safety of 1.34 for the most critical circle of failure. Therefore, by definition of the Corps of Engineers criteria, the seismic stability of the dam is adequate.

SECTION 7
ASSESSMENT AND REMEDIAL MEASURES

7.1 Dam Assessment.

a. Evaluation. The visual inspection and review of the design documentation indicates that the dam, foundation, and appurtenant structures of Hamburg Reservoir are in good condition. The hydrologic/hydraulic calculations presented in Appendix C indicate that the dam will pass about 79 percent of the PMF. Therefore, the spillway system of the structure is considered to be "Inadequate". It is noted that significant property damage is likely to occur downstream during high rates of discharge. The access road to the dam will also be flooded. In the event of overtopping, it is judged that the dam would fail, causing damage to homes downstream and to the water treatment plant. Loss of life is also probable, justifying the "High" hazard classification.

The seepage noted at the downstream toe and beyond does not appear to represent imminent instability, but it is concluded that action should be taken based on a more detailed evaluation of these areas.

b. Adequacy of Information. The design information available, together with the design drawings and construction reports prepared by Glace and Glace, were adequate and of sufficient degree of completeness to evaluate the structure. Construction data was also considered adequate for this evaluation.

c. Urgency. It is concluded that the recommendations presented in Section 7.2 be implemented as soon as practical.

7.2 Remedial Measures.

a. Facilities. It is recommended that the seepage areas downstream of the dam be regraded and drained into the downstream creek. All water, including the seepage from the 30-inch pond drain pipe, should be monitored for changes in rates of flow or changes in turbidity. Any rates of change in seepage or turbidity should be assessed by a registered professional engineer.

The crest should be reestablished to the design elevation. It is strongly suggested that consideration be given to increasing the height of the spillway walls to enable the spillway to pass the PMF.

b. Operation and Maintenance Procedures. Because of the location of the dam upstream of the water treatment facility and populated areas, a formal procedure of observation and warning during periods of high precipitation should be developed and implemented. This procedure should include a method of warning downstream residents that high flows are expected along the creek. If abnormally high flows are expected, procedures for evacuating people within the flood plain should be implemented.

The Owner should also develop a maintenance and inspection checklist to insure that all items are maintained on a regular basis. An all-weather access route should also be established so the dam and appurtenances can be inspected during severe storms.

APPENDIX

A

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM *Hamburg Reservoir*

ID # *PA 00718*

ITEM	REMARKS
AS-BUILT DRAWINGS	*There were no "As-Built" drawings but DER files contained a 20 sheet full size set of construction drawings.*
REGIONAL VICINITY MAP	*See Plate 1, Appendix E. Glace and Glace also provided a regional location plan for the dam.*
CONSTRUCTION HISTORY	*Yes. Glace and Glace Resident Engineer provided monthly reports of the construction and these reports are in DER files.*
TYPICAL SECTIONS OF DAM	*Yes. Data provided by Glace and Glace. See Appendix E for drawings.*
OUTLETS - PLAN	*See Appendix E for drawings.*
DETAILS	
CONSTRAINTS	
DISCHARGE RATINGS	*None available.*
RAINFALL/RESERVOIR RECORDS	*None available.*

ITEM	REMARKS
DESIGN REPORTS	1. *Design drawings were prepared by Glace and Glace (1960). 20/20 sheets were in DER files.*
GEOLOGY REPORTS	*None provided in DER files. See Appendix F of this report.*
DESIGN COMPUTATIONS	*No data available.*
HYDROLOGY & HYDRAULICS	*No data available.*
DAM STABILITY	*Glace and Glace provided a complete summary of their stablity calculations.*
SEEPAGE STUDIES	*None available.*
MATERIALS INVESTIGATIONS	*A summary of the investigations.*
BORING RECORDS	*Records of boring logs were in the design engineer's plans.*
LABORATORY } FIELD }	*A complete set of testing results were in DER files.*
POST-CONSTRUCTION SURVEYS OF DAM	*None*
BORROW SOURCES	*Borrow sources were noted on Glace and Glace drawings and usage was confirmed in the Resident Engineer's reports.*

ITEM	REMARKS
MONITORING SYSTEMS	*None*
MODIFICATIONS	*None*
HIGH POOL RECORDS	*None*
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	*None*
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	*None*
MAINTENANCE OPERATION RECORDS	*None*

ITEM	REMARKS
SPILLWAY PLAN SECTIONS DETAILS	*See Appendix E for details.*
OPERATING EQUIPMENT PLANS & DETAILS	*See Appendix E for details.*
MISCELLANEOUS	1. *"Application Permit" dated 6 April 1960 by the Hamburg Municipal Authority to construct Hamburg Dam.* 2. *"Permit" dated 26 September 1960 by M.K. Goddard, State of Pennsylvania.* 3. *"Specifications for Construction of Impounding Dam and Reservoir", by Glace and Glace, Harrisburg, Pennsylvania.* 4. *"Supplement to Preliminary Report for Borough of Hamburg" December 1957 by Glace and Glace.* 5. *"Engineering Report to the Borough of Hamburg and the Proposed Dam and Reservoir on Furnace Creek" by Glace and Glace, August 1959.* 6. *"Preliminary Report to the Borough of Hamburg" March 1, 1955 by Glace and Glace.* 7. *"Report Upon the Application of the Hamburg Municipal Authority", 15 July 1960.*

APPENDIX

B

CHECK LIST
VISUAL INSPECTION
PHASE I

Name Dam *Hamburg Dam* County *Berks* State *Pennsylvania* National ID # *PA 00718*

Type of Dam *Earth & Rock Fill* Hazard Category *I (High)*

Date(s) Inspection *18 July 1978* Weather *Clear, Hot & Humid* Temperature *80-90- F*

Pool Elevation at Time of Inspection *949±* M.S.L. Tailwater at Time of Inspection *N/A* M.S.L.

Inspection Personnel:

Brady Bisson *Vince McKeever* *John H. Frederick, Jr.*

Mary Beck *Joh Boschuk, Jr.*

John Boschuk, Jr. Recorder

Remarks:

Mr. Russ Hartman, Cartaker, represented the Hamburg Municipal Authority and was on site to exercise valves and explain the operation of the dam.

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	*N/A*	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	*N/A*	
DRAINS	*N/A*	
WATER PASSAGES	*N/A*	
FOUNDATION	*N/A*	

CONCRETE/MASONRY DAMS

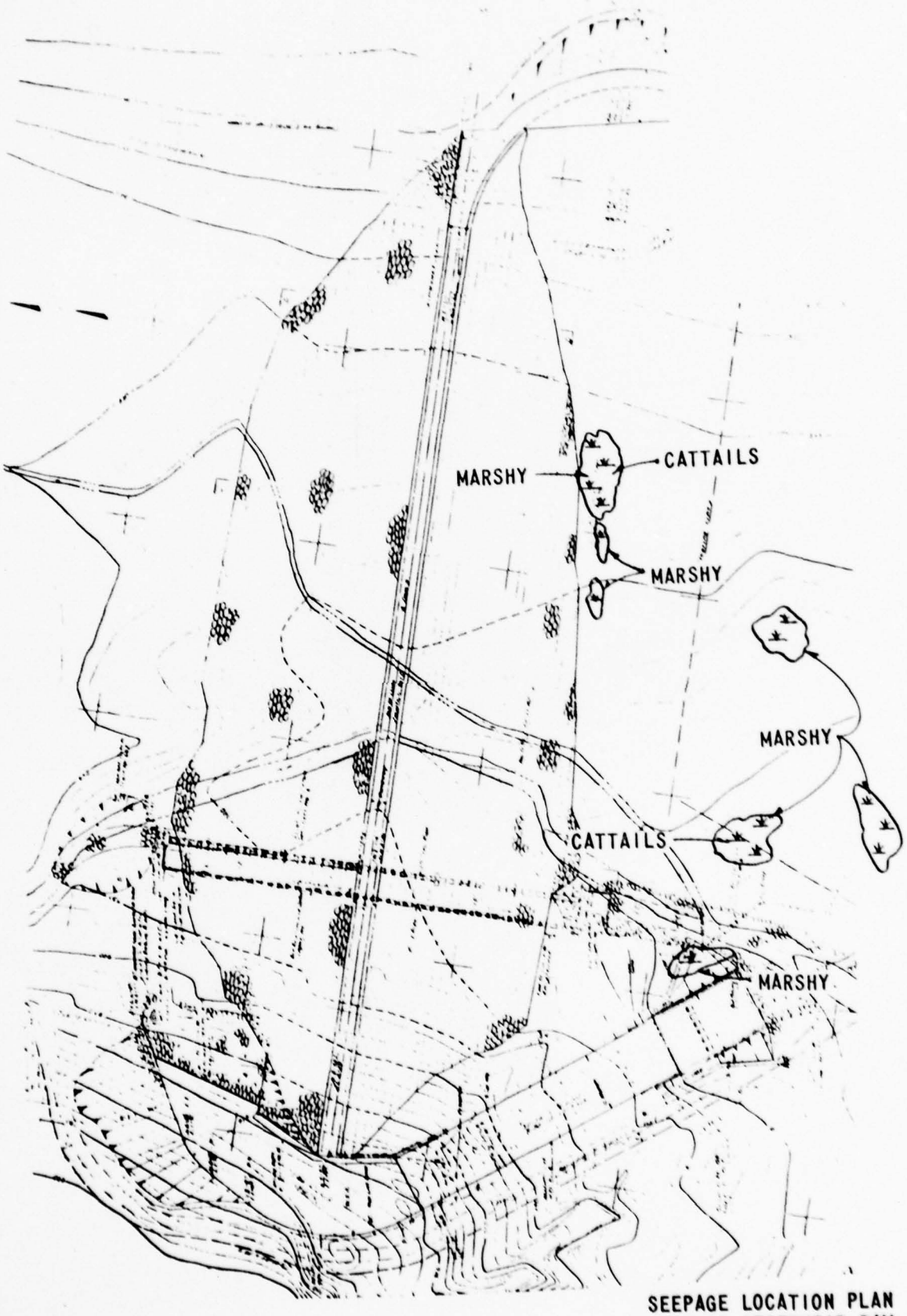
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	*N/A*	
STRUCTURAL CRACKING	*N/A*	
VERTICAL AND HORIZONTAL ALIGNMENT	*N/A*	
MONOLITH JOINTS	*N/A*	
CONSTRUCTION JOINTS	*N/A*	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	*None observed.*	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	*None observed.*	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	*None observed.*	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	*No unusual vertical or horizontal distortions observed.*	
RIPRAP FAILURES	*None observed but the lower portion of the slope is uneven and could have been in that condition since construction.*	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
DRAINS	*Yes. One spring was piped from the reservoir area during construction into the intake tower discharge conduit. Details were not available since this was done quickly during the construction phase. Flow from the piped spring was observed discharging through the exit of the outlet conduit.*	
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	*No discontinuities observed.*	
ANY NOTICEABLE SEEPAGE	*Yes. See sheet 5a. One seepage zone delineated by a 10 foot circle of cattails was noted which drained via a channel parallel to the outlet channel eventually dischrging into the natural channel approximately 120 feet downstream of the impact basin. Several other marshy areas were noted as shown on sheet 5a.*	
STAFF GAGE AND RECORDER	*None*	



SEEPAGE LOCATION PLAN
HAMBURG RESERVOIR DAM

SHEET 5a OF 11

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	*Structure could not be observed since it is buried under the embankment.*	
INTAKE STRUCTURE	*Good condition. Valves were exercised.*	
OUTLET STRUCTURE	*Good condition. No signs of distress.*	
OUTLET CHANNEL	*Rock lined channel was stable and showed no signs of distress. The largest storm experienced by the reservoir was Hurricane Agnes, June 1972, and the channel performed well.*	
EMERGENCY GATE	*N/A*	
BRIDGE	*The bridge was inspected and observed to be in good condition.*	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	*Good condition with minor spalling at crest probably caused by ice forces.*	
APPROACH CHANNEL	*Good condition with a rock bottom and concrete wing walls. Some (1" to 2") rotation was observed on the left wing wall but the condition does not appear to be an immediate problem.*	
DISCHARGE CHANNEL	*Good condition with no significant deterioration, spalling or cracking of concrete.*	
BRIDGE AND PIERS	*None*	

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	*N/A*	
APPROACH CHANNEL	*N/A*	
DISCHARGE CHANNEL	*N/A*	
BRIDGE AND PIERS	*N/A*	
GATES AND OPERATION EQUIPMENT	*N/A*	

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	*None*	
OBSERVATION WELLS	*None*	
WEIRS	*None*	
PIEZOMETERS	*None*	
OTHER	*None*	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	*Steep, well vegetated slopes with rock outcrops. There is a road around the reservoir for access.*	
SEDIMENTATION	*The upstream stream contains a weir to catch sediment. Stream flows are directed into a paved channel which enters into a sedimentation pond and then discharges into the reservoir. The sedimentation pond was clean. Discharge into the reservoir is via a 24" pipe.*	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	*There were no major obstructions but the densely wooded areas would significantly absorb much of the energy of a flood wave or high flows associated with high runoff storms.*	
SLOPES	*Valley gradient for the first 1/4 mile is approximately four percent, for the next 1 to 1 1/2 miles the slope gradually decreases to approximately one percent. Side slopes range for near vertical to 2H:1V. The flood plain varies from farm land to dense woods.*	
APPROXIMATE NO. OF HOMES AND POPULATION	*There are at least nine homes on the flood plain for the first 1 to 1 1/2 miles downstream. Loss of life and significant property damage is expected if the dam fails.*	

APPENDIX

C

HAMBURG RESERVOIR
CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: *100% wooded, no residential development.*

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): *952 (92 Acre-Feet).*

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): *959.5 (145 Acre-Feet est.)*

ELEVATION MAXIMUM DESIGN POOL: *958.7*

ELEVATION TOP DAM: *961.0*

SPILLWAY

a. Elevation *952*

b. Type *Concrete ogee weir and concrete chute.*

c. Width *30 feet.*

d. Length --

e. Location Spillover *Right abutment.*

f. Number and Type of Gates *None.*

OUTLET WORKS:

a. Type *Intake tower.*

b. Location *At upsteam toe*

c. Entrance inverts *944.3 and 934.3*

d. Exit inverts *908.0*

e. Emergency draindown facilities *15 inch inlet at bottom of tower at 921.5*

HYDROMETEOROLOGICAL GAGES:

a. Type *None.*

b. Location

c. Records

MAXIMUM NON-DAMAGING DISCHARGE: *Not determined.*

DAM SAFETY ANALYSIS
HYDROLOGIC/HYDRAULIC DATA

Date: 9/5/78
By: MFB
Sheet: 2 of 7

DAM Hamburg Reservoir Nat. ID No. PA00718 DER No. 6-450

ITEM/UNITS	Permit/Design Files (A)	Calc. from Files/Other (B)	Calc. from Observations (C)
1. Min. Crest Elev., ft.	959.5		
2. Freeboard, ft.			
3. Spillway(1) Crest Elev, ft.	952.0		
3a. Secondary(2) Crest Elev, ft.	–		
4. Max. Pool Elev., ft.	958.7		
5. Max. Outflow(3), cfs	1970.0		
6. Drainage Area, mi^2	1.5		1.4
7. Max. Inflow(4), cfs			
8. Reservoir Surf. Area, Acre			20
9. Flood Storage(5), Acre-Feet			
10. Inflow Volume, ft^3			

Reference all figures by number or calculation on attached sheets:

Example: 3A - Drawing No. xxx by J. Doe, Engr., in State File No. yyyy.

NOTES:

(1) Main emergency spillway.

(2) Secondary ungated spillway.

(3) At maximum pool, with freeboard, ungated spillways only.

(4) For columns B, C, use PMF.

(5) Between lowest ungated spillway and maximum pool.

Date: 9/5/78
By: MFB
Sheet: 3 of 7

HYDROLOGIC/HYDRAULIC CALCULATIONS (cont.)

Item (from Sheet 2)	Source
1A, 3A, 4A	Undated drawings in the State files
6A, 5A	Application Report dated July 15, 1960
6C, 8C	USGS Map Hamburg, PA (1969)

BY MEB DATE 2/5/78 SUBJECT Hamburg Reservoir Hydrology / Hydraulics SHEET 4 OF 7

CHKD. BY ____ DATE ____ JOB No. ____

Classification (Ref. - Recommended Guidelines for Safety Inspection of Dams)

1. The hazard potential is rated as "High" as there would be loss of life if the dam failed.

2. The size classification is "Intermediate" based on its 50 ft height.

3. The spillway design flood, based on size and hazard classification, is the probable maximum flood (PMF).

Hydrologic and Hydraulic Analysis

1. Original Design
   Criteria - the spillway shall discharge not less than 1965 cfs
   Design values
   - spillway capacity = 1970 cfs at some unknown head
   - high water elevation = 958.70

2. Evaluation of Features
   Spillway capacity
   Minimum distance between weir and top of wall = 7.5 ft
   Length of weir = 30 ft
   Assume C = 3.8

$$Q = C L H^{3/2} = 2340 \text{ cfs}$$

Peak PMF inflow
Information from Corps of Engineers, Balt. District, indicates the use of Pine Creek, D.A. = 11 mile^2 and peak PMF inflow of 15,060 cfs. as a comparable watershed
Peak inflow, Q_I.

$$Q_I = \left(\frac{4.5}{11}\right)^{0.8} 15{,}060 = 3060 \text{ cfs}$$

BY MFB DATE 2/5/78 SUBJECT Hamburg Reservoir Hydrology / Hydraulics SHEET 5 OF 7

CHKD. BY DATE JOB No.

Volume of Inflow, V_I

PMP = 25.5 inches (from TP-40)
Assume 90% runoff

$$V_I = \frac{0.9 \cdot 25.5}{12} 1.5 \cdot 640 = 1836 \text{ Ac-Ft}$$

Available flood water storage, V_S

Surface area (7 Ac) x Head (7.5)
V_S = 52.5 Ac-Ft SAY 53 Ac-Ft

Required flood water storage - see sheets 6 & 7

$$V_R = (1 - \frac{Q_o}{Q_I}) V_I$$

$$= (1 - \frac{2940}{3060}) 1836$$

$$= 432 \text{ Ac-Ft} >> V_S = 53 \text{ Ac-Ft}$$

Therefore, spillway is "Inadequate"

As a triangular inflow hydrograph is used, a 50% PMF storm will have $Q_I = 0.5 \cdot 3060$ & $V_I = 0.5 \cdot 1836$

Q_I = 1530 cfs < Q_o, therefore, spillway will discharge 0.5 PMF storm

Percent PMF storm passed

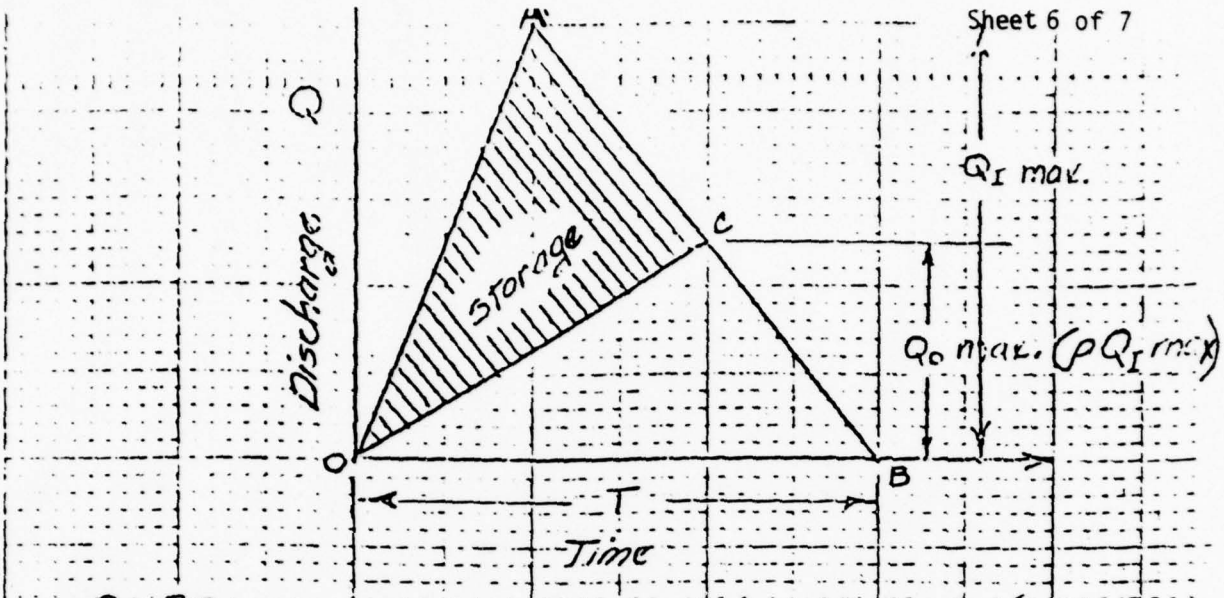
$$53 = (1 - \frac{2940}{X \cdot 3060}) X 1836$$

X = 79.9%

Required Q_o to pass 100% PMF

$$53 = (1 - \frac{Q_o}{3060}) 1836 \; ; \; Q_o = 2970 \text{ cfs}$$

Downstream Conditions - the first downstream highway bridge (1.5 mi.) is 5.5ft x 3.5 ft. The capacity of the bridge was not determined because of the large intervening watershed which prevents correlation of bridge capacity with discharge from the dam.



PURPOSE: Establish relationship between maximum spillway discharge and storage required to pass flood hydrograph without exceeding maximum pool level.

$$\frac{\Delta AOC}{\Delta AOB} = \frac{\Delta AOB - \Delta COB}{\Delta AOB} = 1 - \frac{\Delta COB}{\Delta AOB}$$

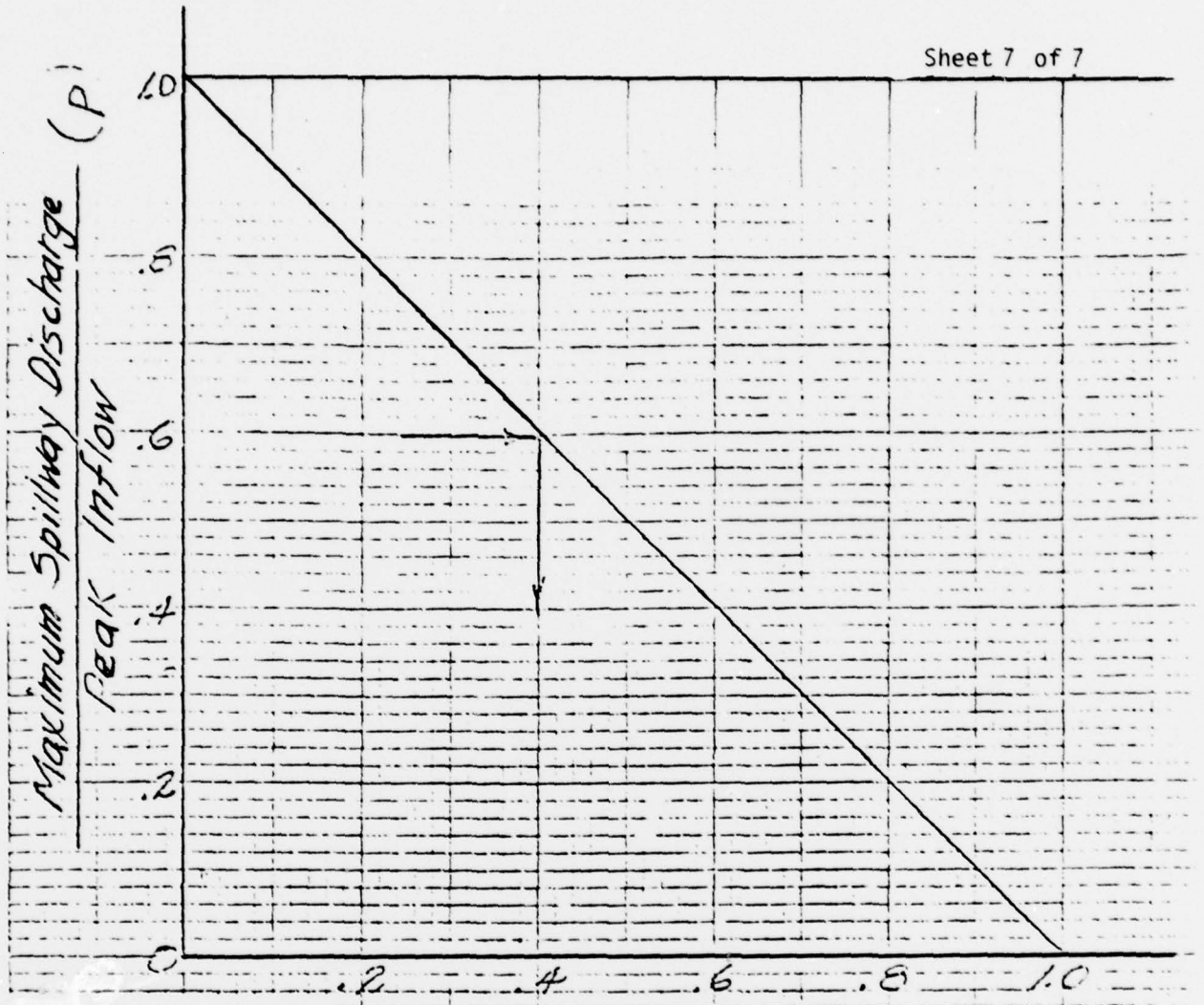
$$\frac{\Delta AOC}{\Delta AOB} = 1 - \frac{T \rho Q_{I\,max}/2}{T\, Q_{I\,max}/2} = 1 - \rho$$

$$\Delta AOC = (1-\rho)\,\Delta AOB \quad \text{where } 0 \le \rho \le 1.0$$

ρ	ΔAOC
1.00	0
0.75	0.25 ΔAOB
0.50	0.50 ΔAOB
0.25	0.75 ΔAOB
0	1.00 ΔAOB

REFERENCE

PRELIMINARY ENGINEER TECHNICAL LETTER NO. 1110-2-
25 January 1978

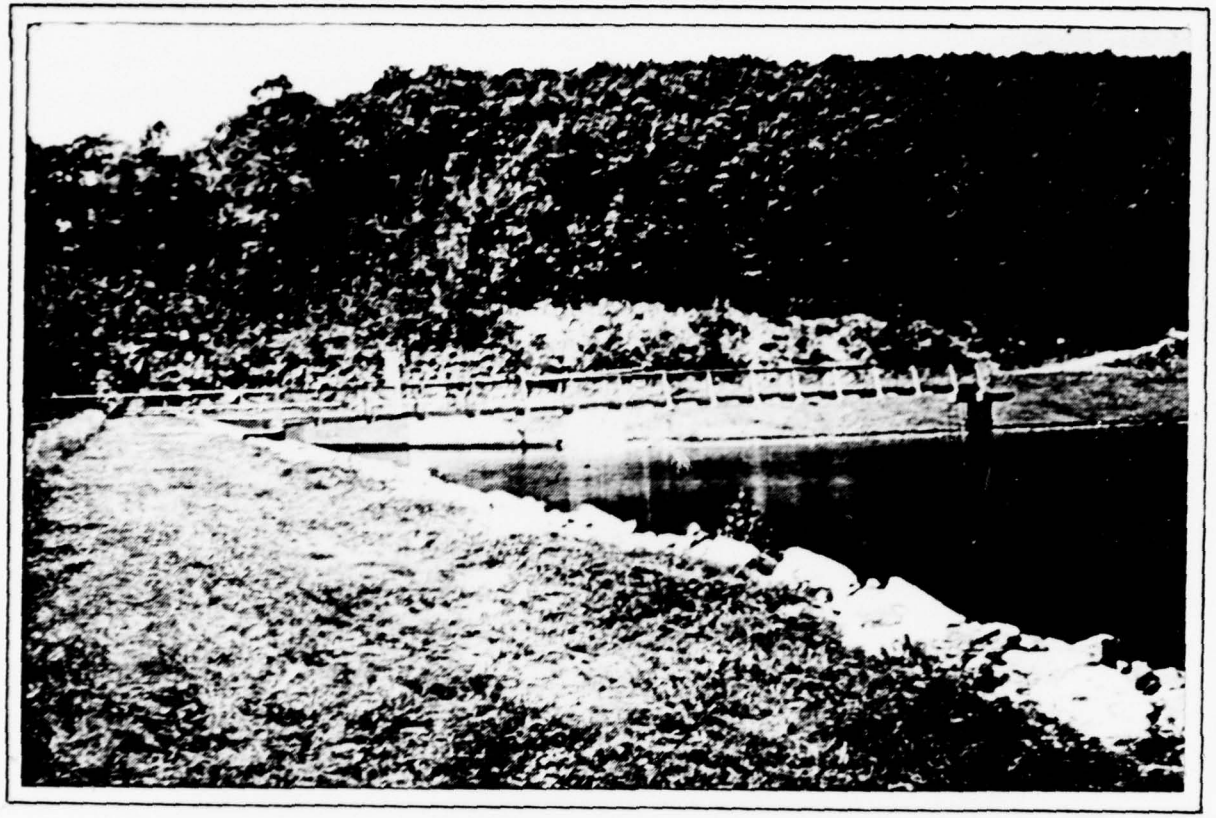


Steps to obtain required reservoir to pass inflow hydrograph without overtopping dam.

1. Obtain maximum spillway discharge
2. Develop inflow hydrograph
3. Compute relationship of maximum spillway capacity to peak inflow
4. Read relationship of required reservoir storage to volume of inflow hydrograph from curve

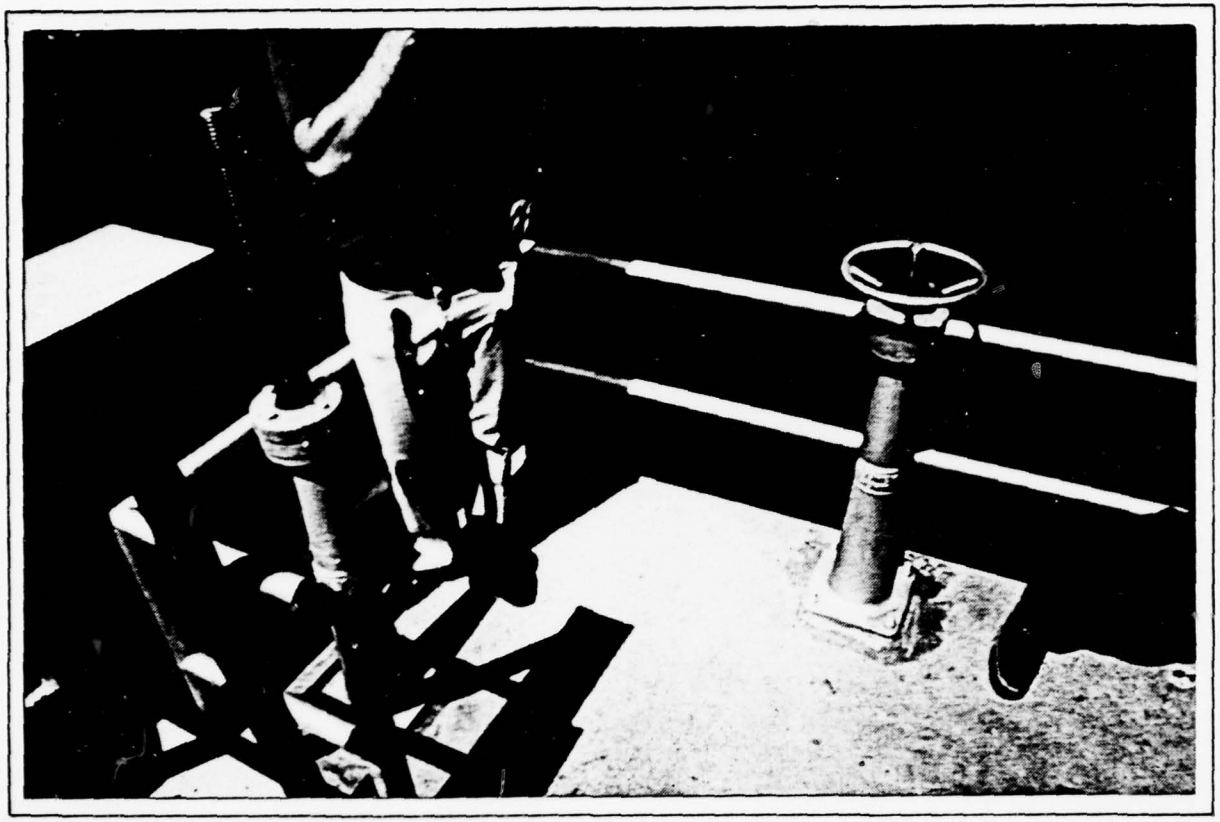
APPENDIX

D



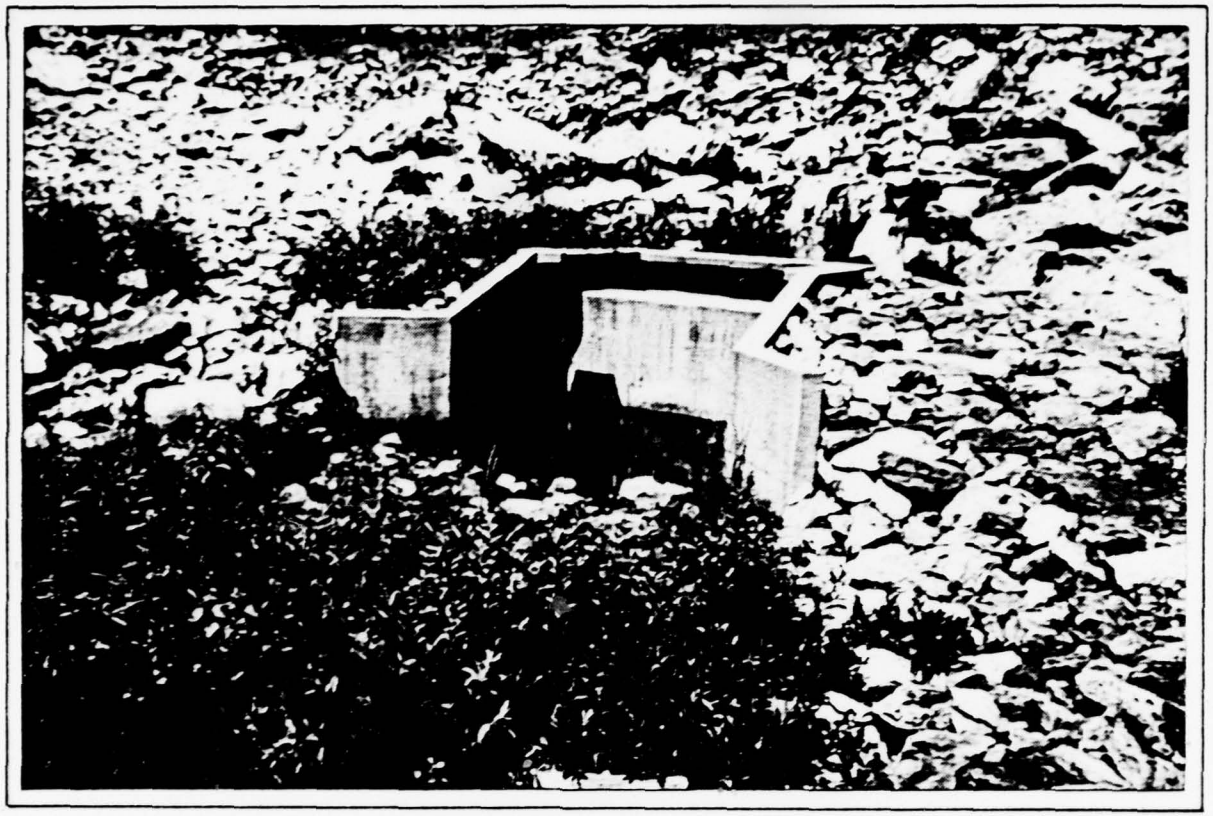
VIEW OF BRIDGE AND INTAKE TOWER.

PHOTOGRAPH NO. 1



INTAKE TOWER AND INTAKE VALVES.

PHOTOGRAPH NO. 2

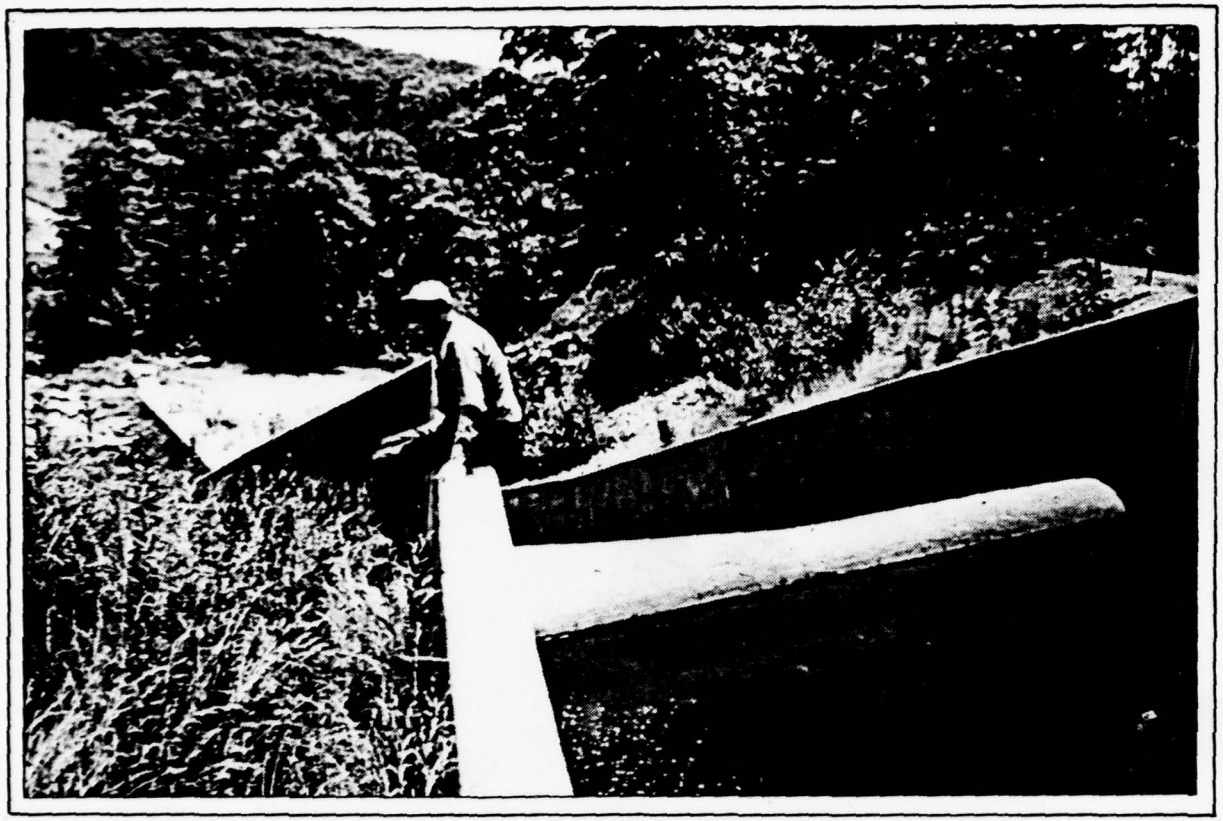


OUTLET PIPE AND IMPACT BASIN.

PHOTOGRAPH NO. 3

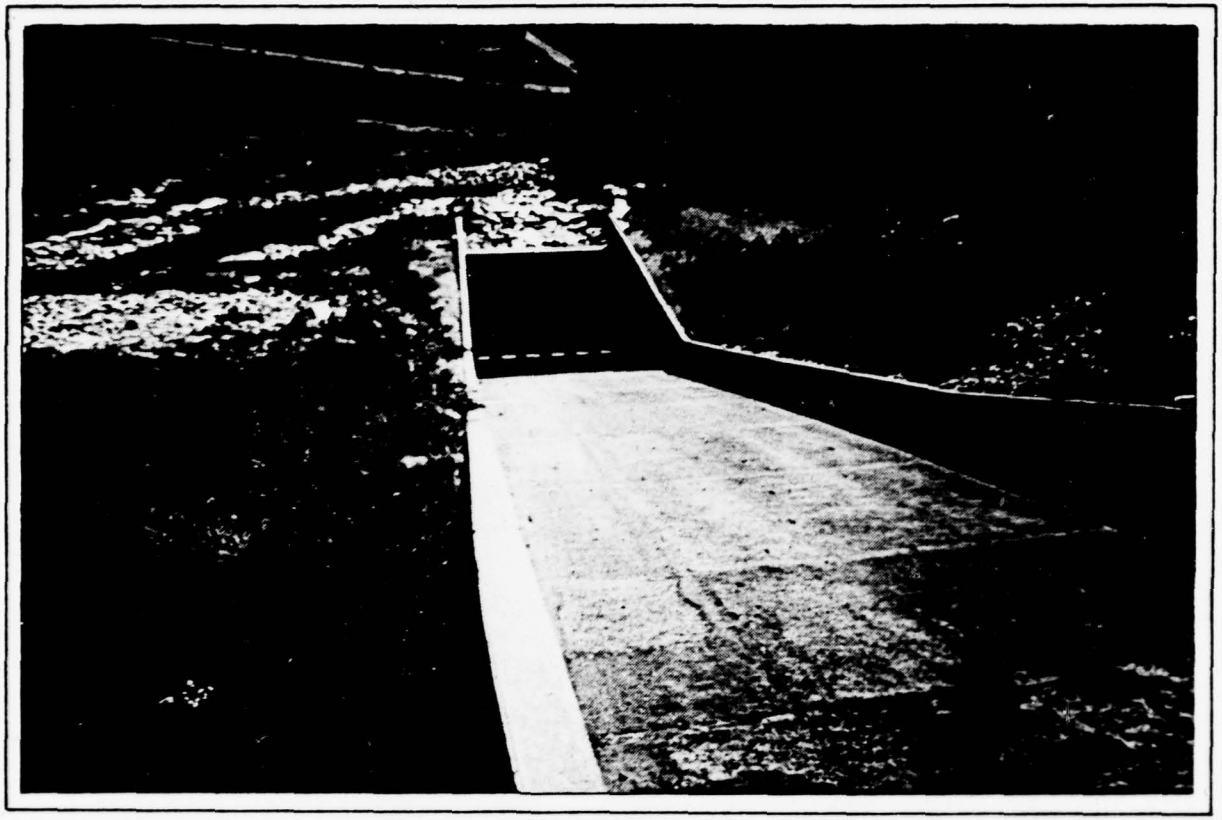
INLET CHANNEL TO SPILLWAY. NOTE
RIPRAP SLOPE.

PHOTOGRAPH NO. 4



SPILLWAY CREST.

PHOTOGRAPH NO. 5

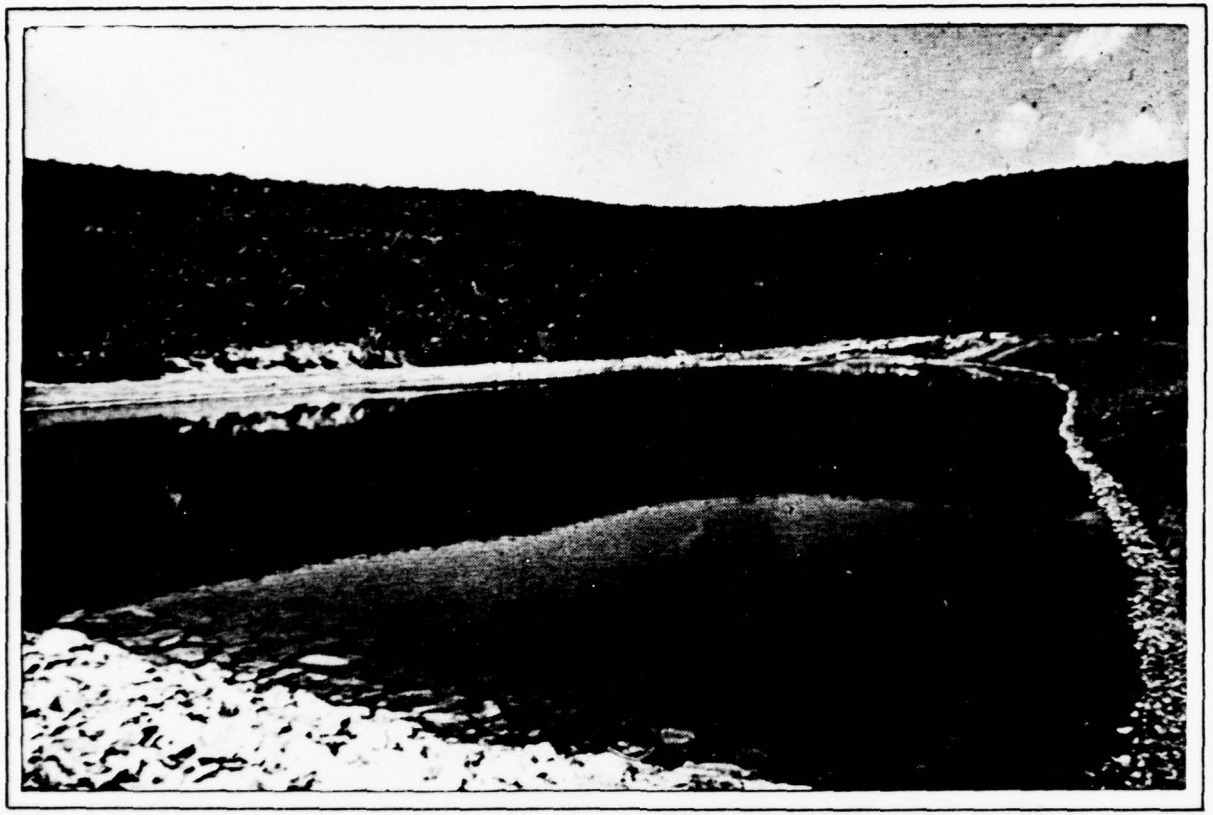


VIEW LOOKING DOWN SPILLWAY CHUTE
INTO STILLING BASIN.

PHOTOGRAPH NO. 6

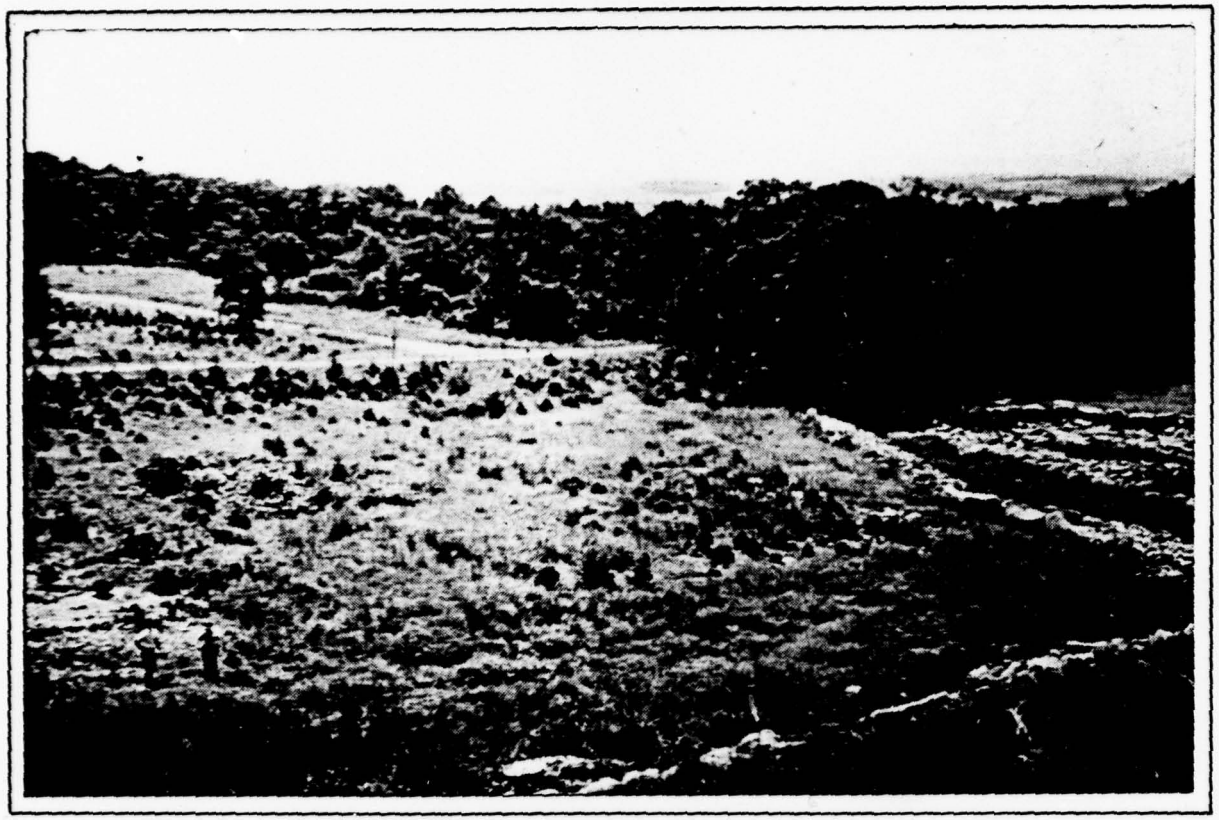
DOWNSTREAM CHANNEL WHERE OUTLET PIPE
AND SPILLWAY CHANNELS MERGE.

PHOTOGRAPH NO. 7



OVERVIEW OF RESERVOIR TAKEN FROM
LEFT ABUTMENT.

PHOTOGRAPH NO. 8

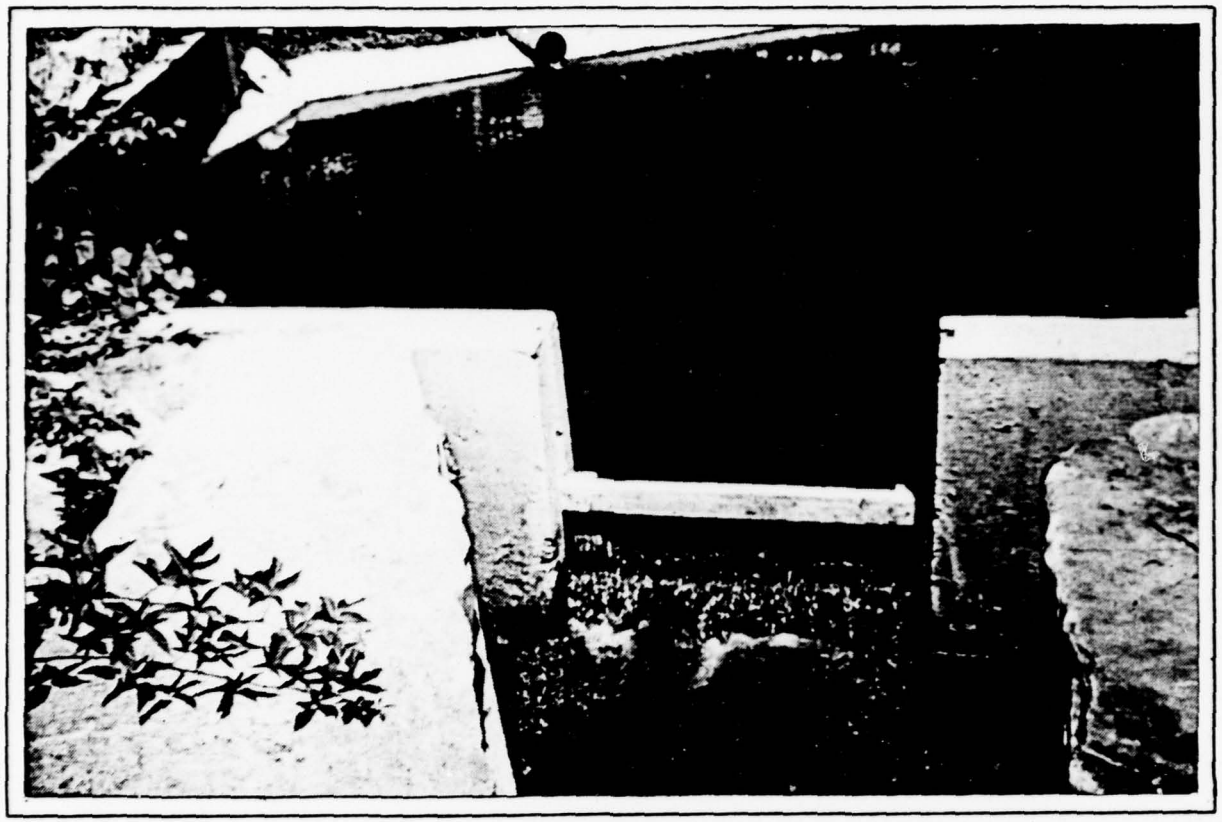


OVERVIEW OF DOWNSTREAM AREA BELOW DAM. LUSH GREEN AREAS WITH CATTAILS DENOTE SEEPAGE AREAS.

PHOTOGRAPH NO. 9

VIEW DOWNSTREAM LOOKING UPSTREAM
TOWARDS DAM.

PHOTOGRAPH NO. 10

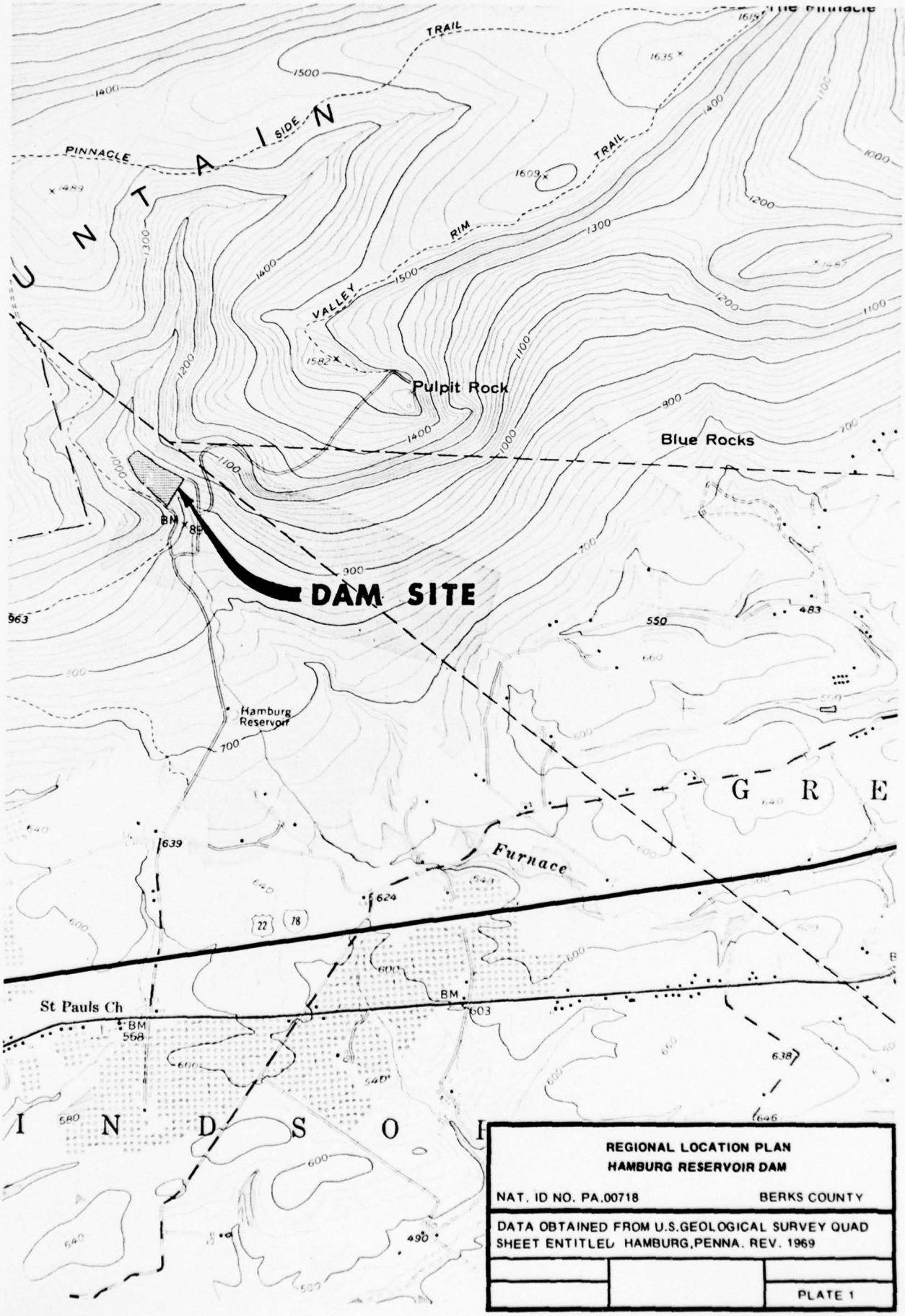


SEDIMENT POND AND WEIR AT UPPER
END OF RESERVOIR USED TO REDUCE
RESERVOIR TURBIDITY.

PHOTOGRAPH NO. 11

APPENDIX

E

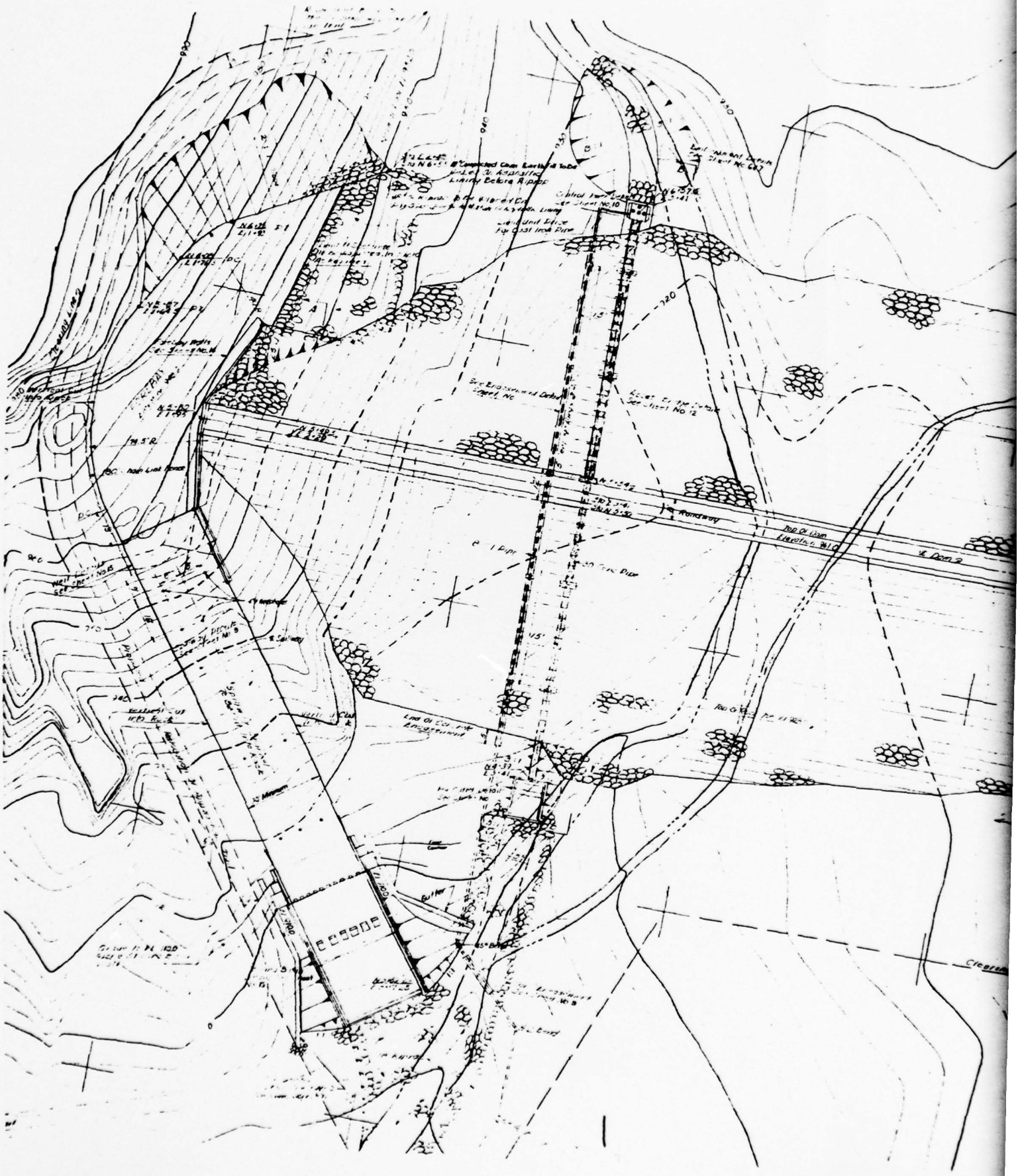


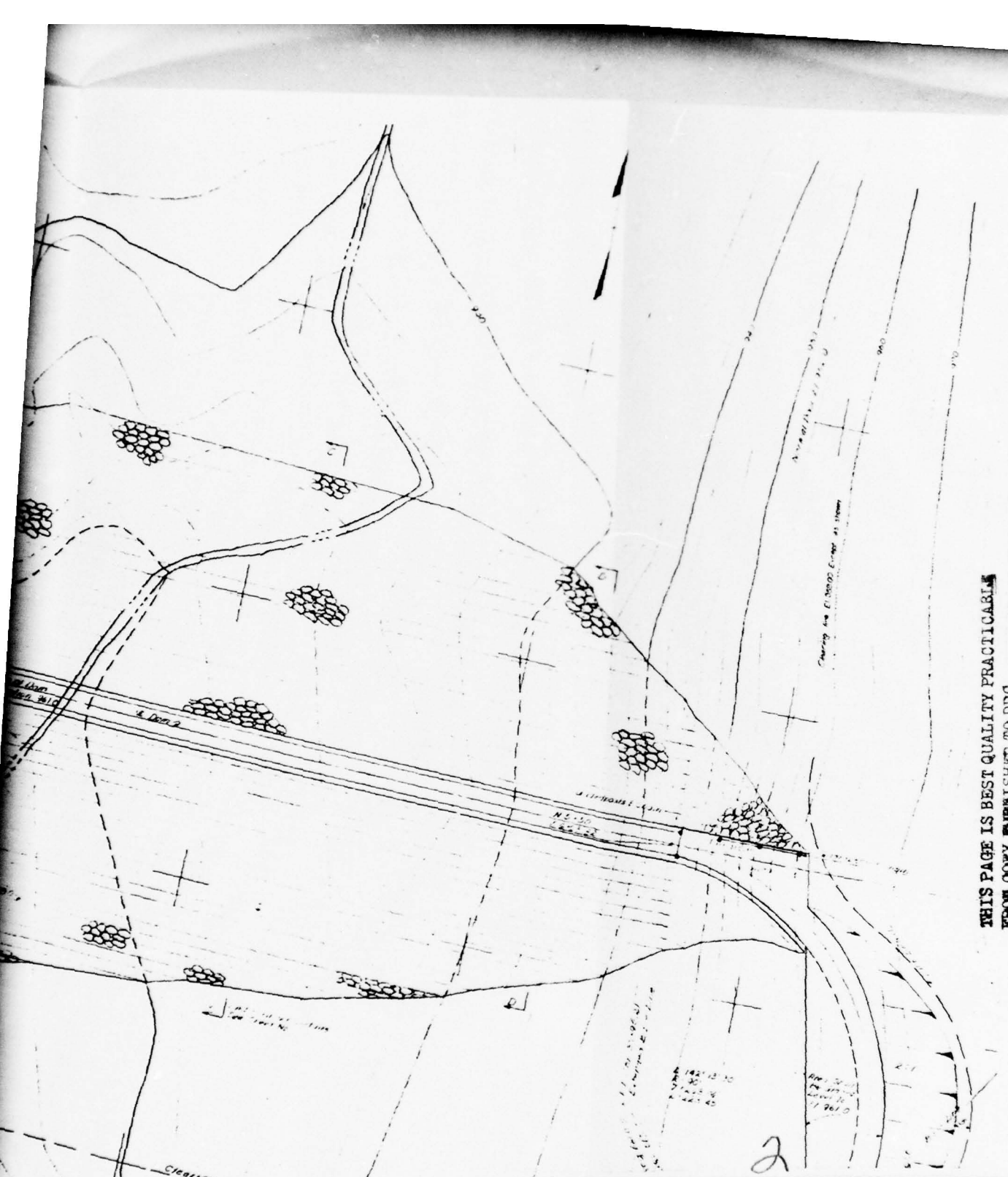
REGIONAL LOCATION PLAN
HAMBURG RESERVOIR DAM

NAT. ID NO. PA.00718 BERKS COUNTY

DATA OBTAINED FROM U.S.GEOLOGICAL SURVEY QUAD SHEET ENTITLED HAMBURG,PENNA. REV. 1969

PLATE 1



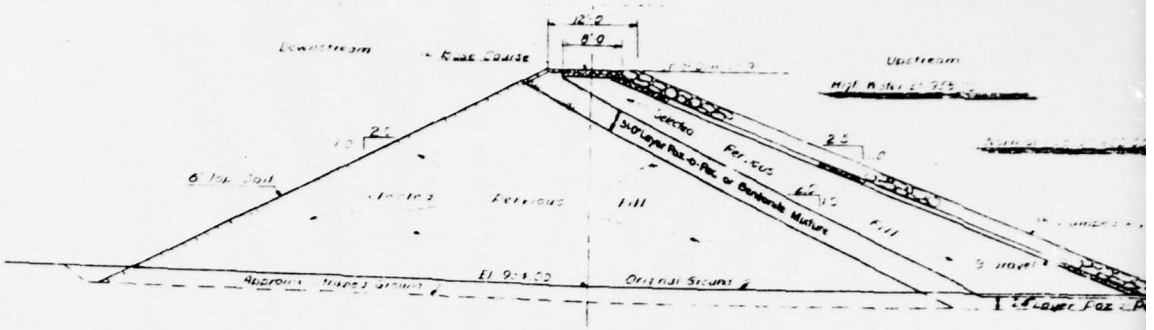


PLAN OF DAM & APPURTENANT STRUCTURES
HAMBURG RESERVOIR DAM

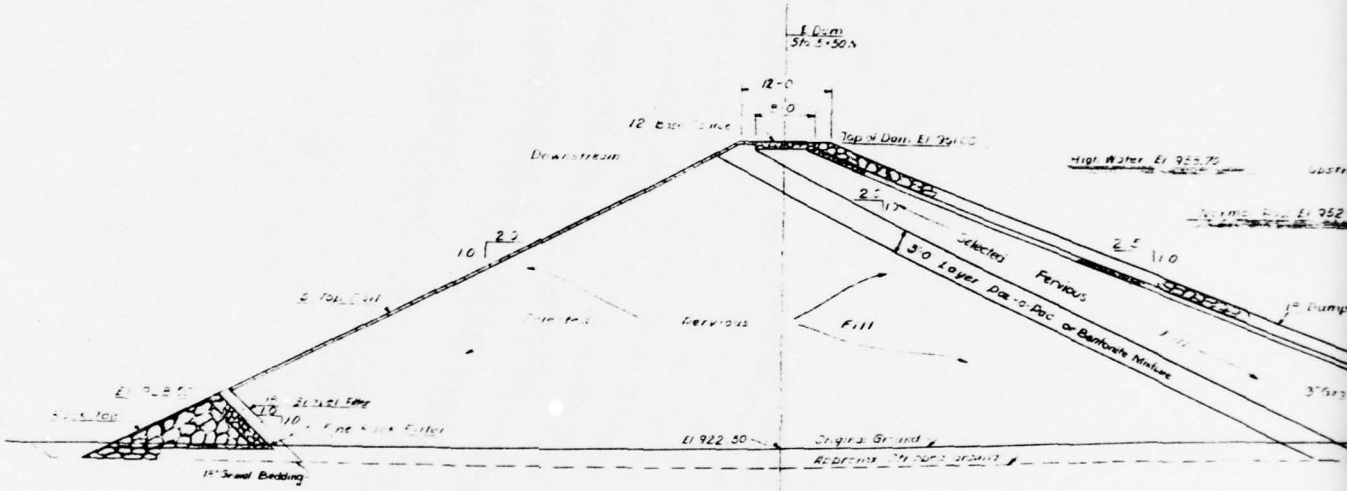
NAT. ID NO.PA.00718 BERKS COUNTY

DATA OBTAINED FROM GLACE & GLACE CONSULTING ENGINEERS, PHILA.,PA. FILE CODE 5733, SHEET NO. 5 OF 20

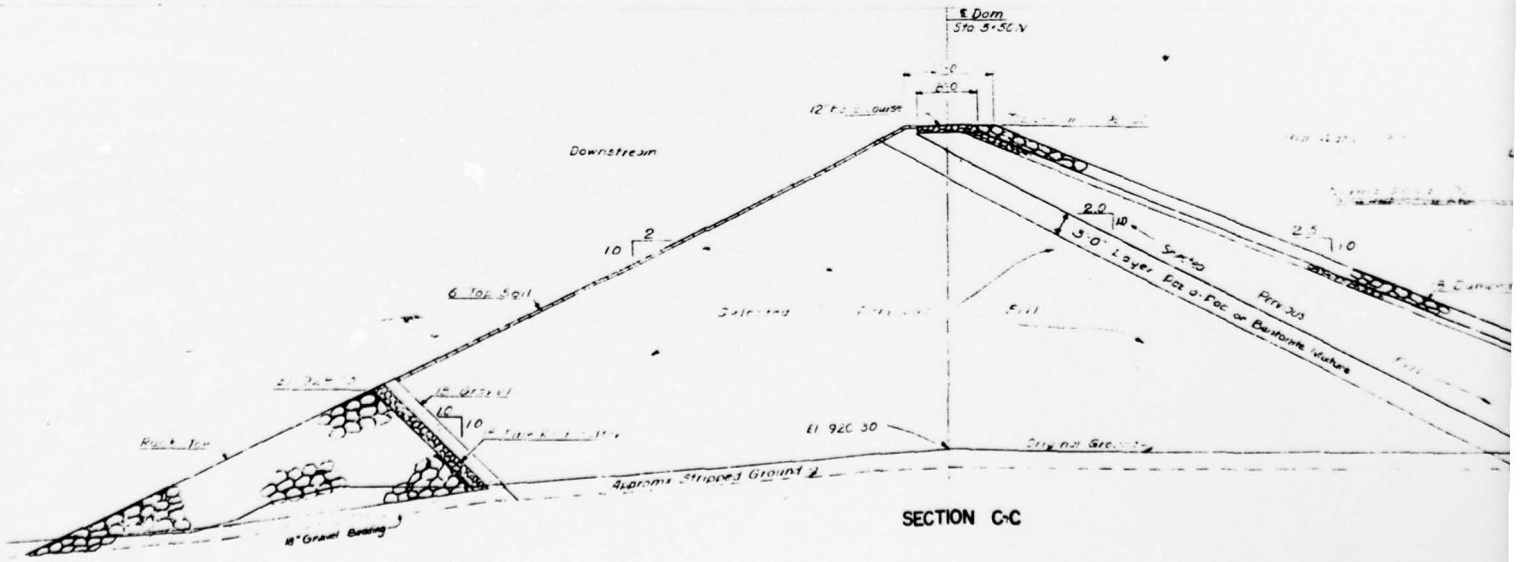
PLATE 2



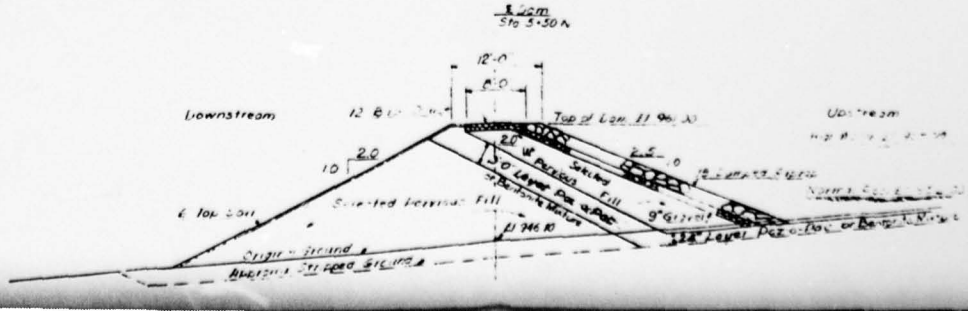
SECTION A-A

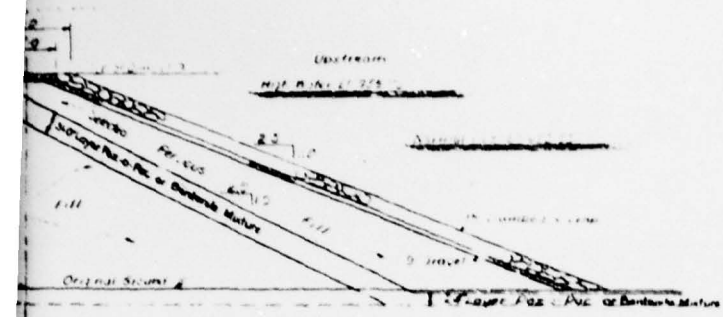


SECTION B-B

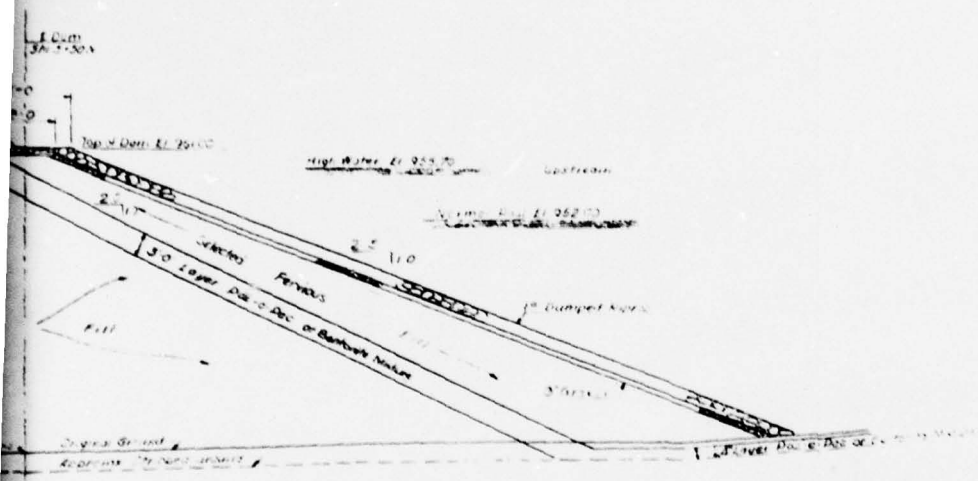


SECTION C-C

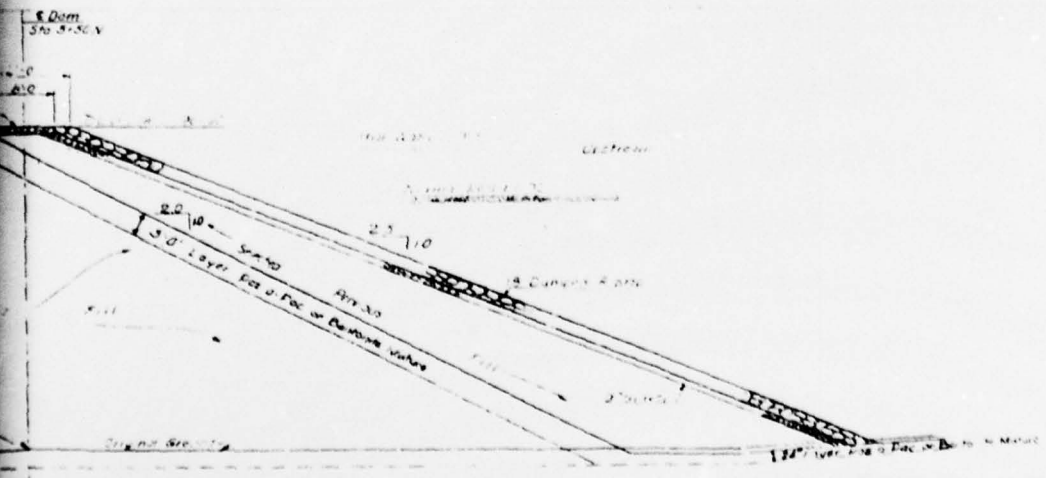




TION A-A



CTION B-B



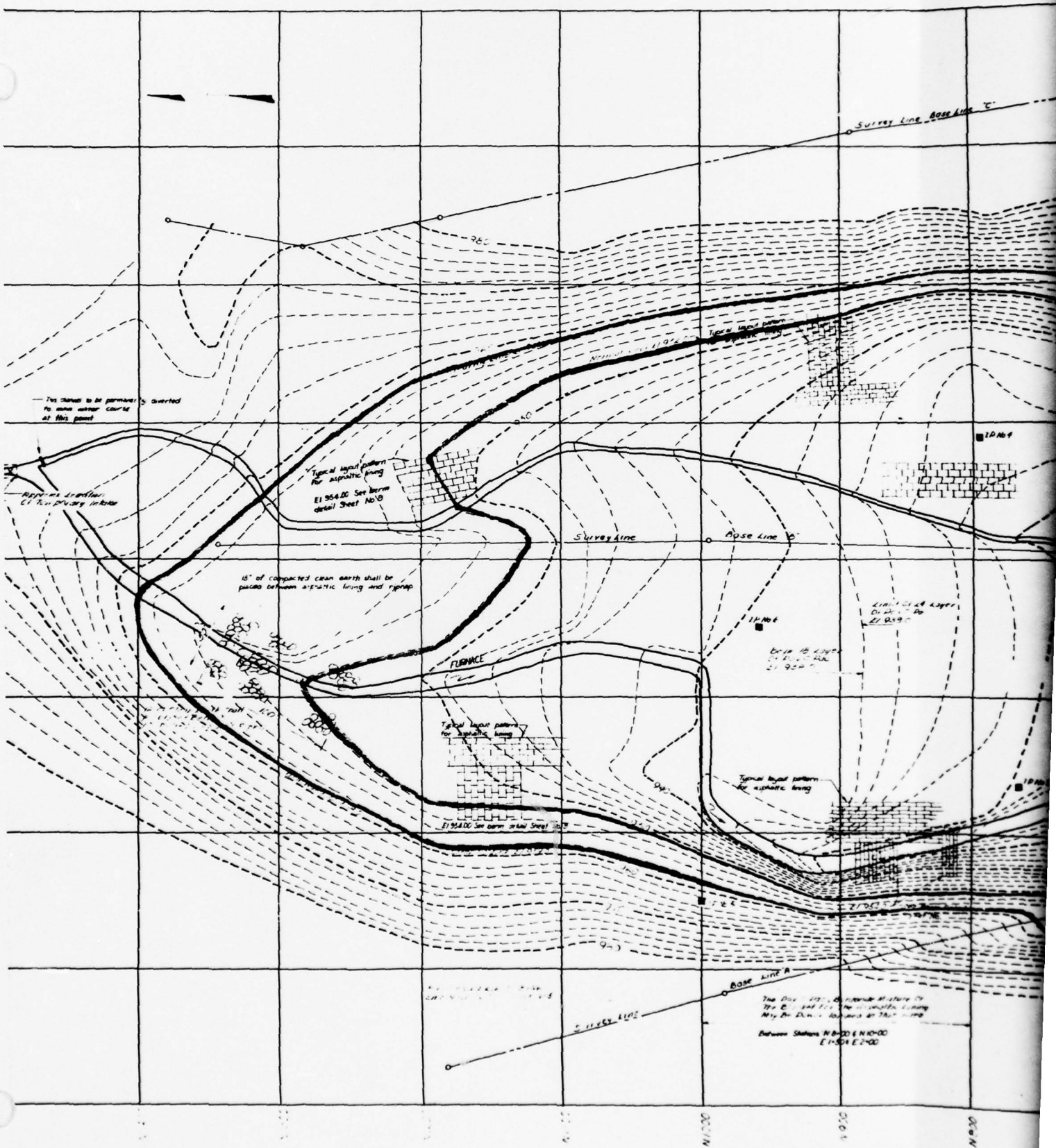
CTION C-C

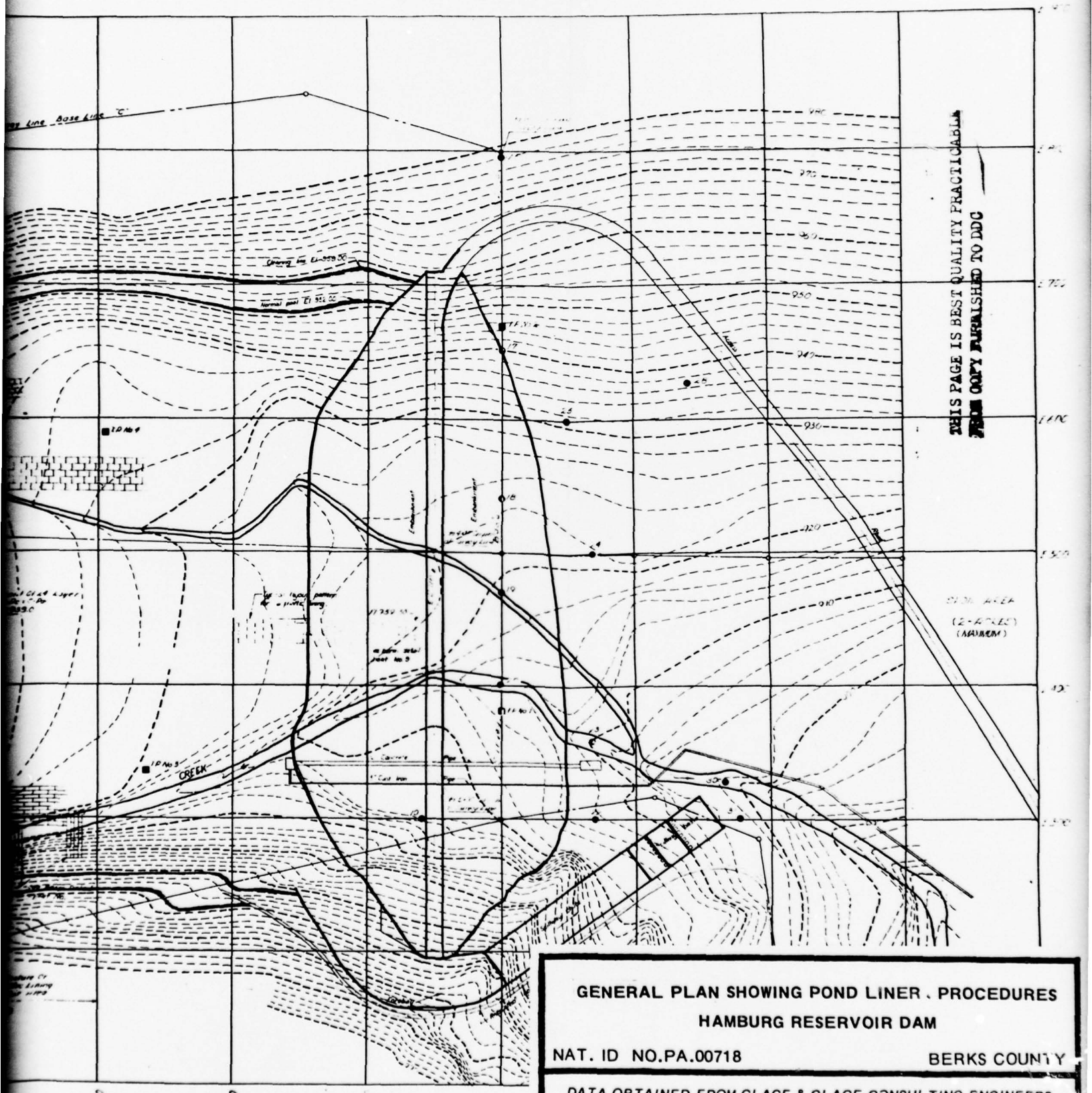
TYPICAL EMBANKMENT SECTIONS
HAMBURG RESERVOIR DAM

NAT. ID NO.PA.00718 — BERKS COUNTY

DATA OBTAINED FROM GLACE & GLACE CONSULTING ENGINEERS, PHILA.,PA. FILE CODE 5733, SHEET NO. 6 OF 20

PLATE 3


Survey Line Base Line 'C'
Typical layout pattern for asphaltic lining
El 954.00 See berm detail Sheet No 9
Survey Line
Base Line 'B'
15" of compacted clean earth shall be placed between asphaltic lining and riprap
FURNACE
Typical layout pattern for asphaltic lining
El 954.00 See berm detail Sheet No 9
Typical layout pattern for asphaltic lining
Survey Line
Base Line 'A'
Between Stations N 8+00 E N 10+00
E 1+50 E 2+00
N 6+00
N 7+00
N 8+00

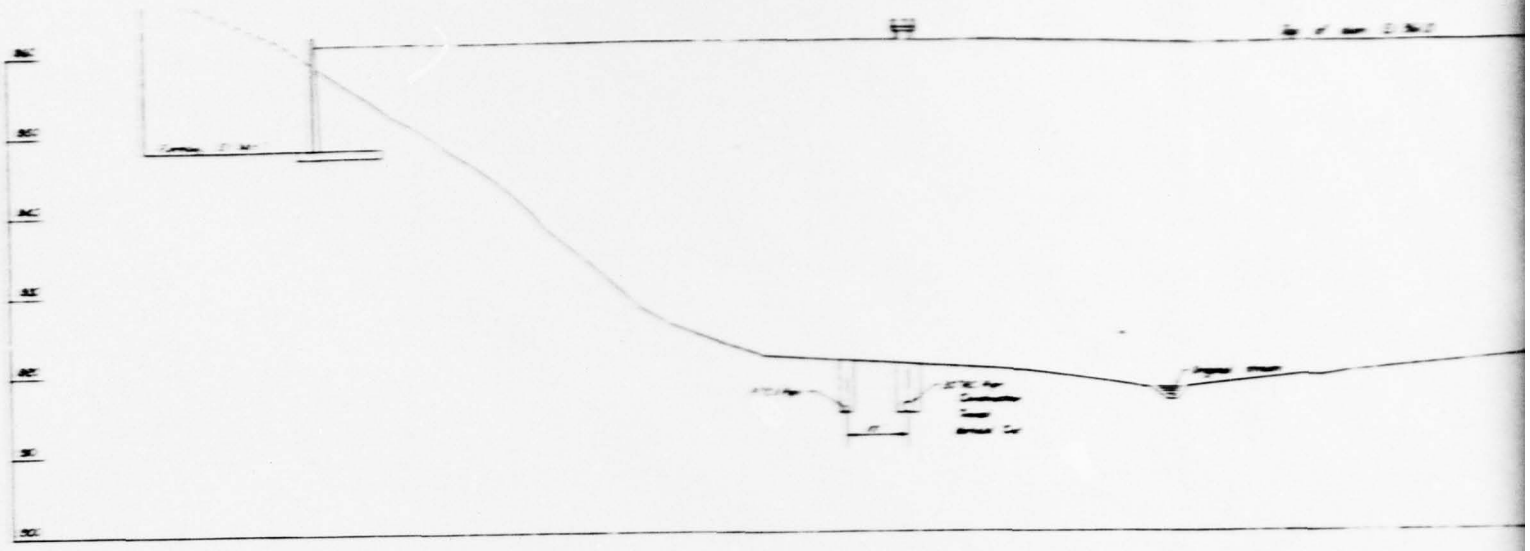


GENERAL PLAN SHOWING POND LINER . PROCEDURES
HAMBURG RESERVOIR DAM

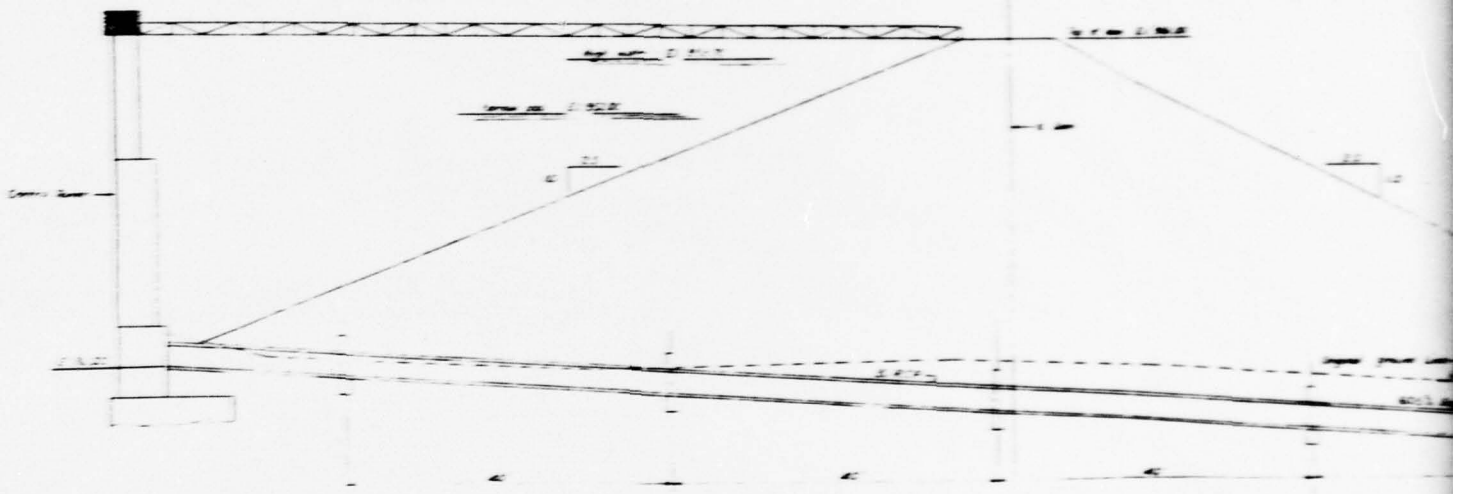
NAT. ID NO.PA.00718 BERKS COUNTY

DATA OBTAINED FROM GLACE & GLACE CONSULTING ENGINEERS, PHILA.,PA. FILE CODE 5733, SHEET NO. 4 OF 20

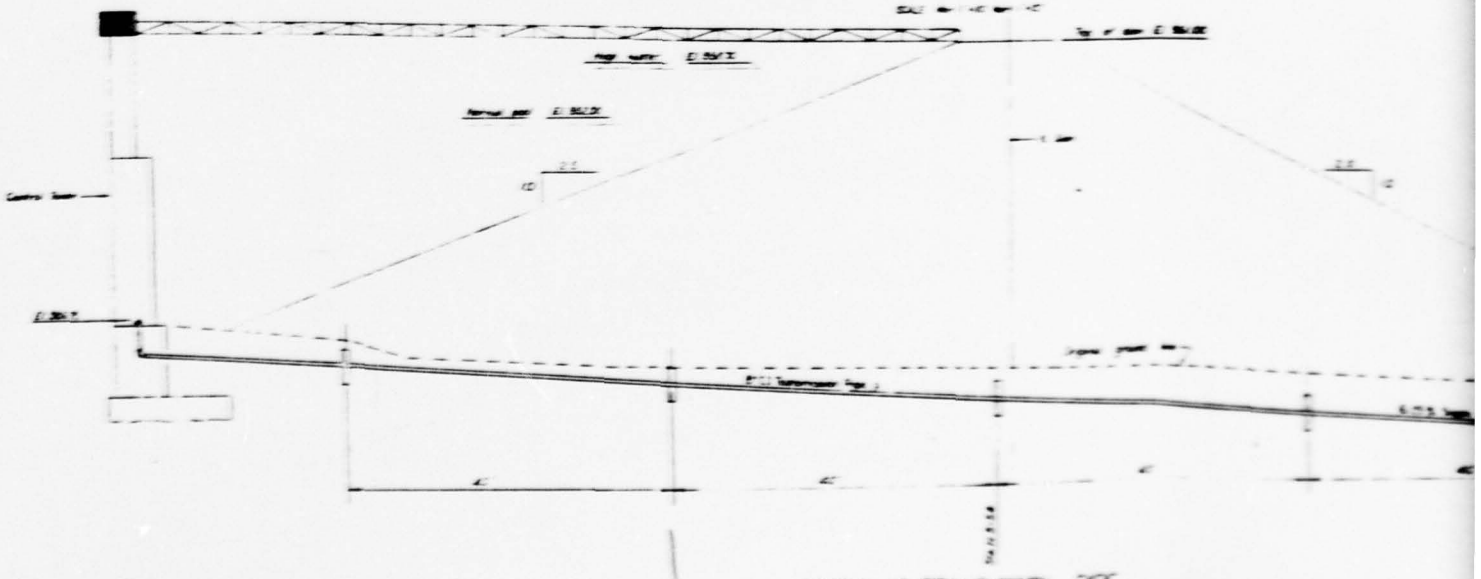
	9	PLATE 4



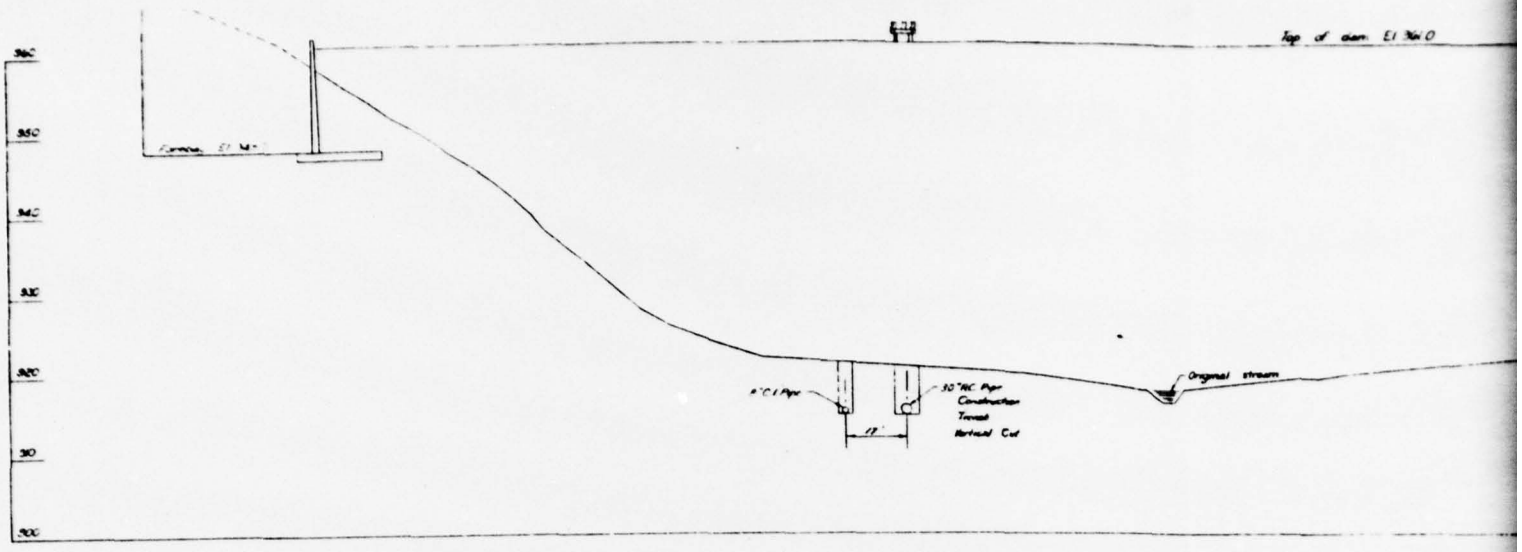
PROFILE E DAM



PROFILE 3" DNOUT

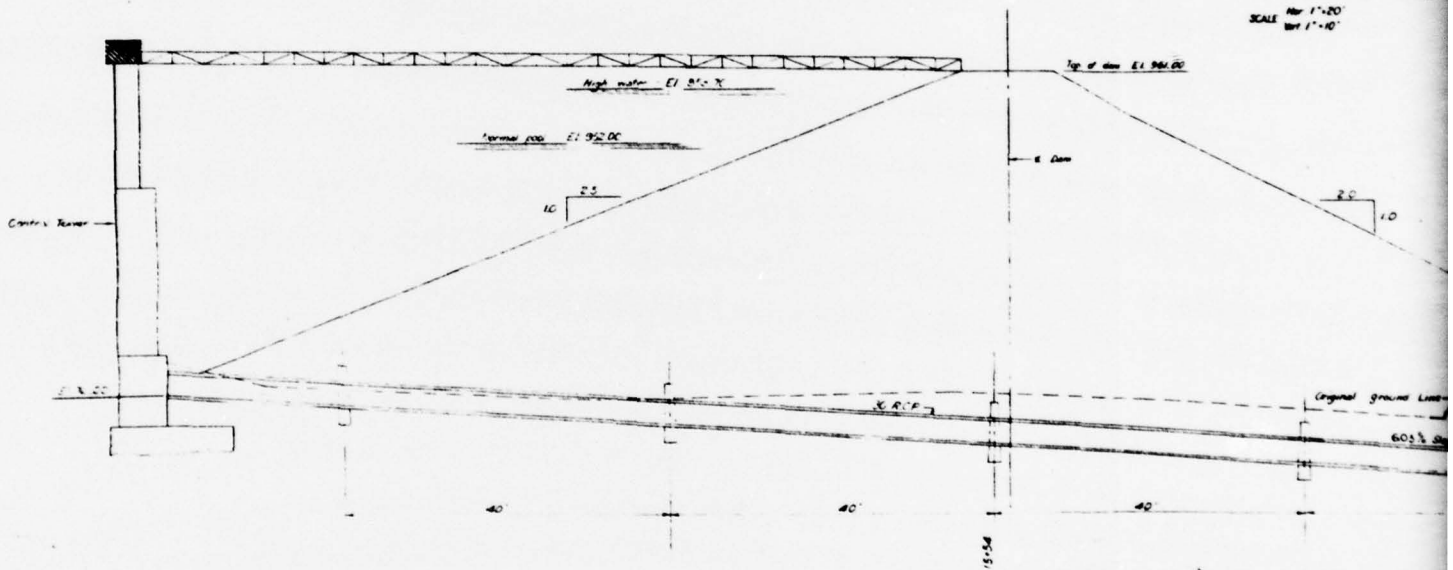


PROFILE 8" TRANSMISSION PIPE



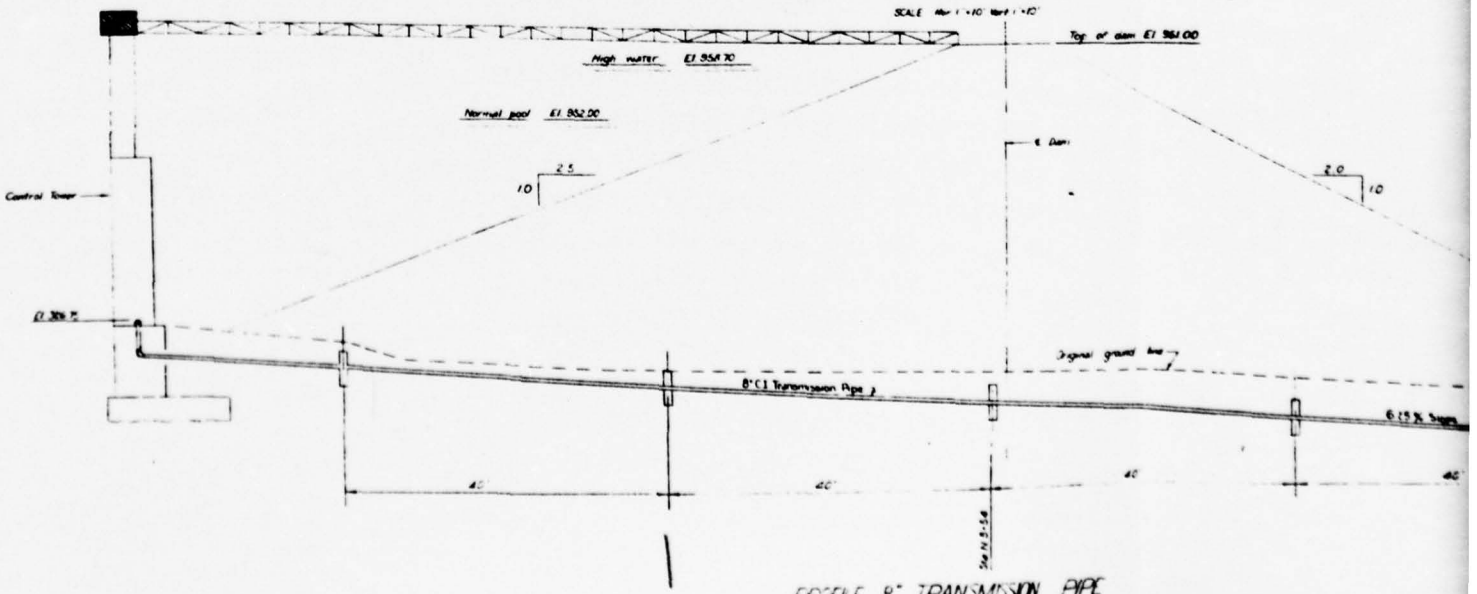
PROFILE & DAM

SCALE Hor 1"=20'
Vert 1"=10'

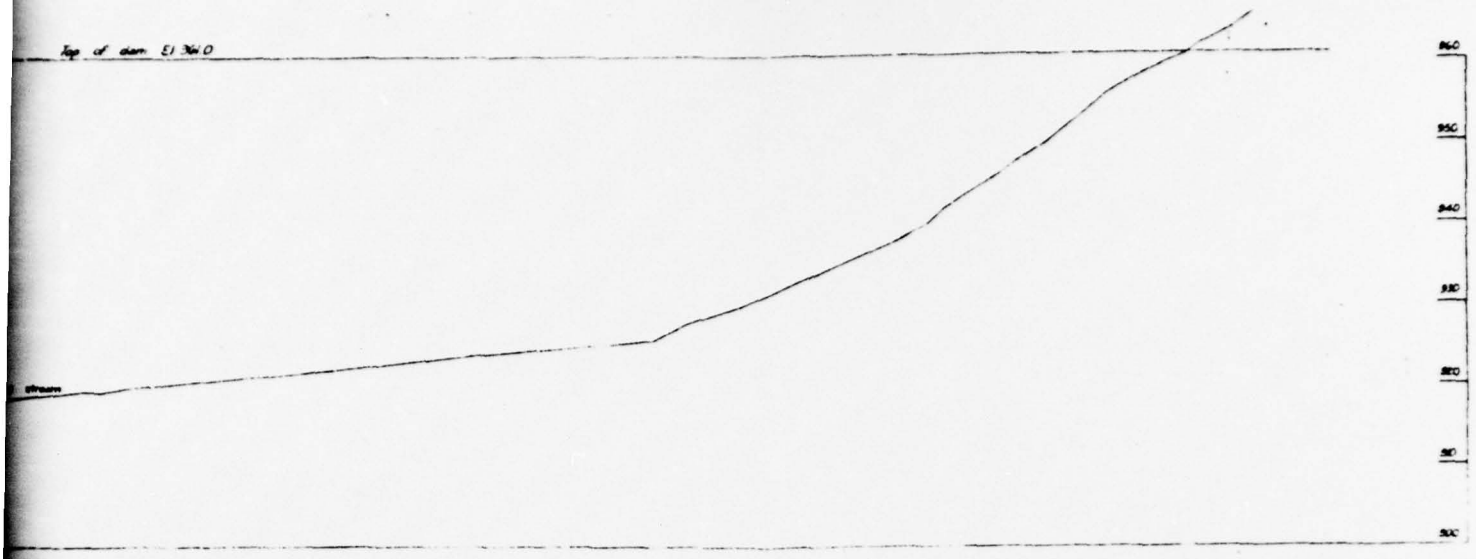


PROFILE 30" CONDUIT

SCALE Hor 1"=10' Vert 1"=10'

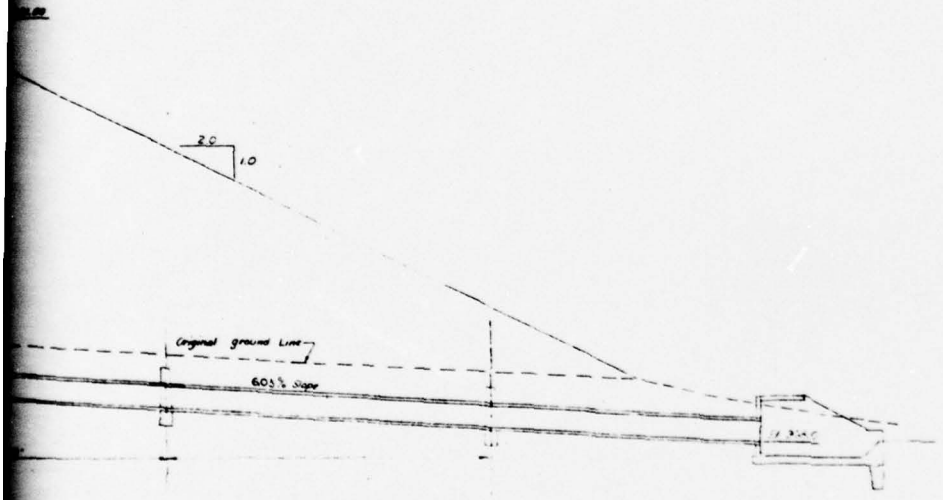


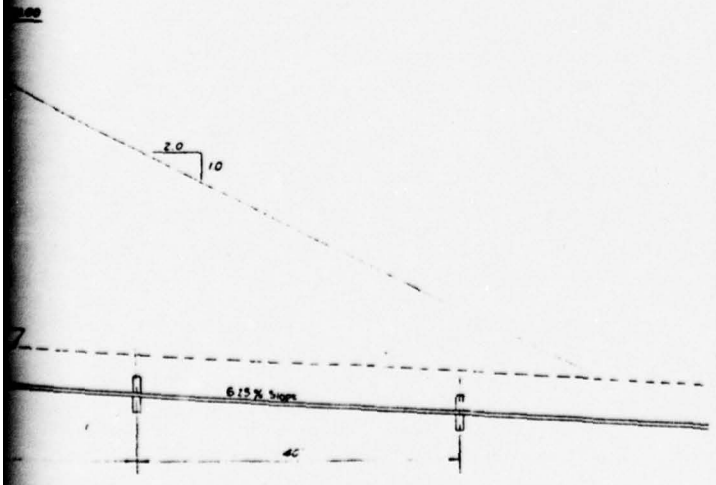
PROFILE 8" TRANSMISSION PIPE



PROFILE ℄ DAM

SCALE Hor 1"=20'
Ver 1"=10'





2

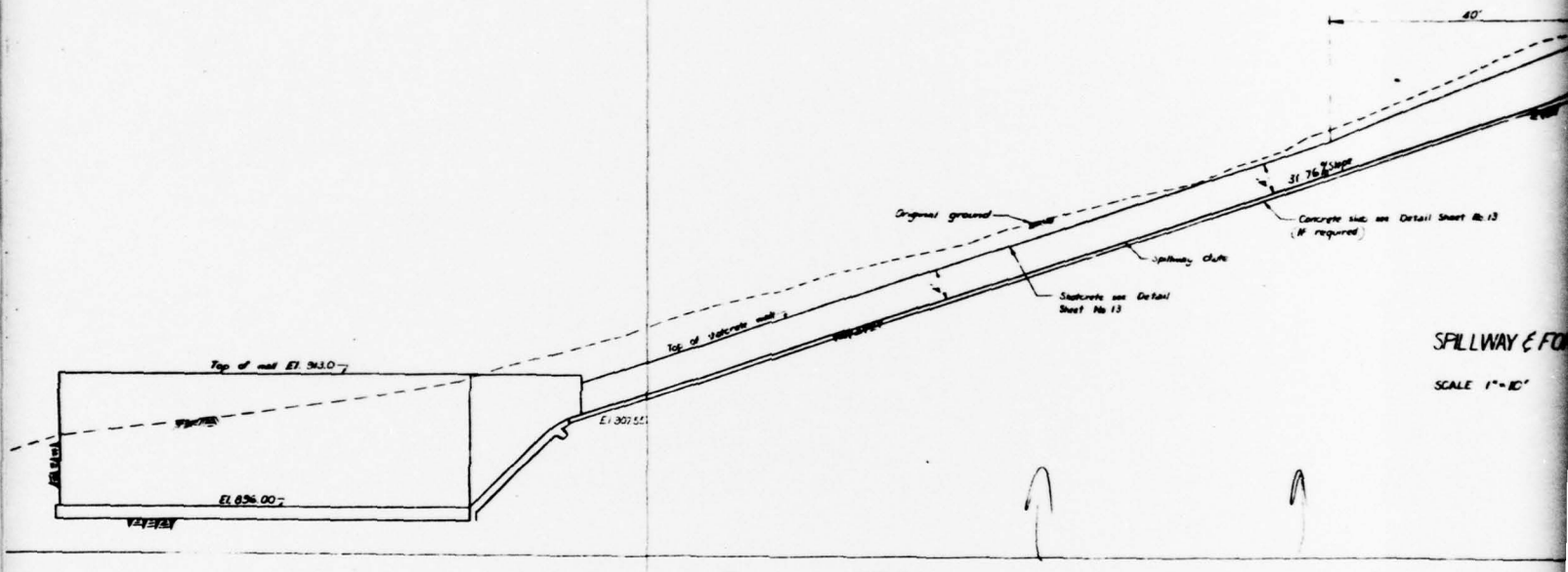
PROFILES OF WATER SUPPLY AND POND DRAIN SYSTEMS

HAMBURG RESERVOIR DAM

NAT. ID NO.PA.00718 BERKS COUNTY

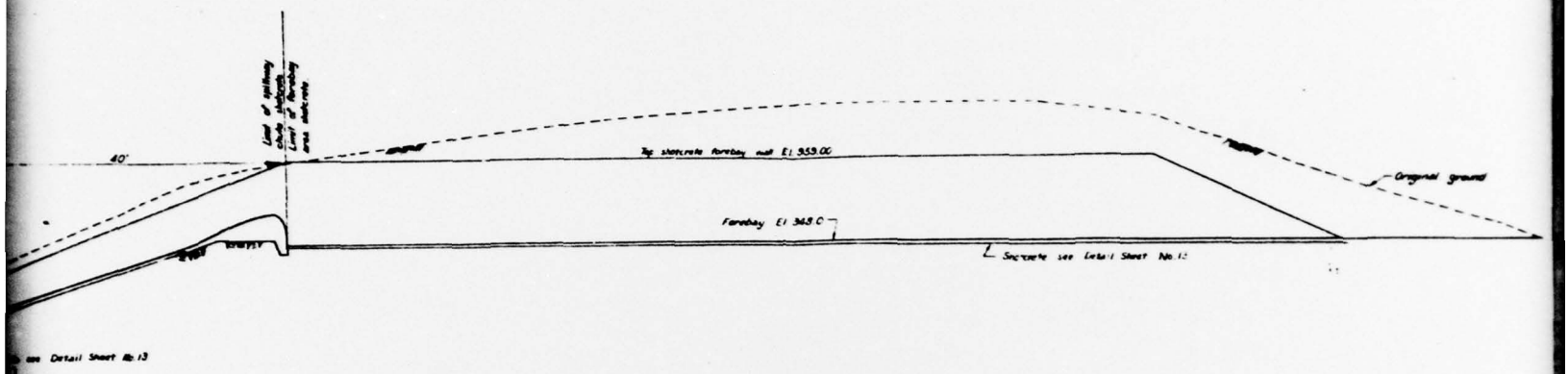
DATA OBTAINED FROM GLACE & GLACE CONSULTING ENGINEERS, PHILA.,PA. FILE CODE 5733, SHEET NO. 8 OF 20

PLATE 5



SPILLWAY & FO

SCALE 1"=10'

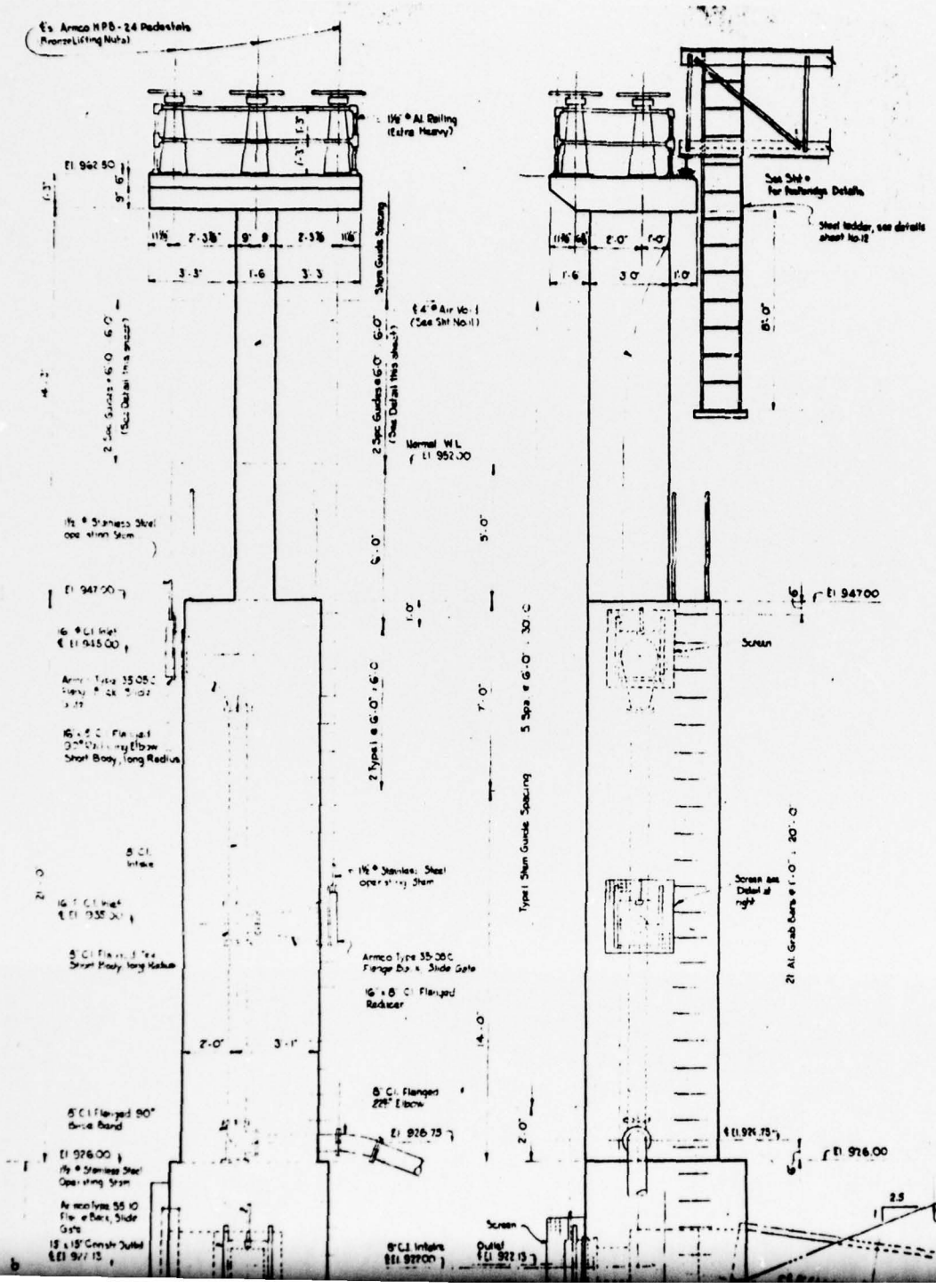


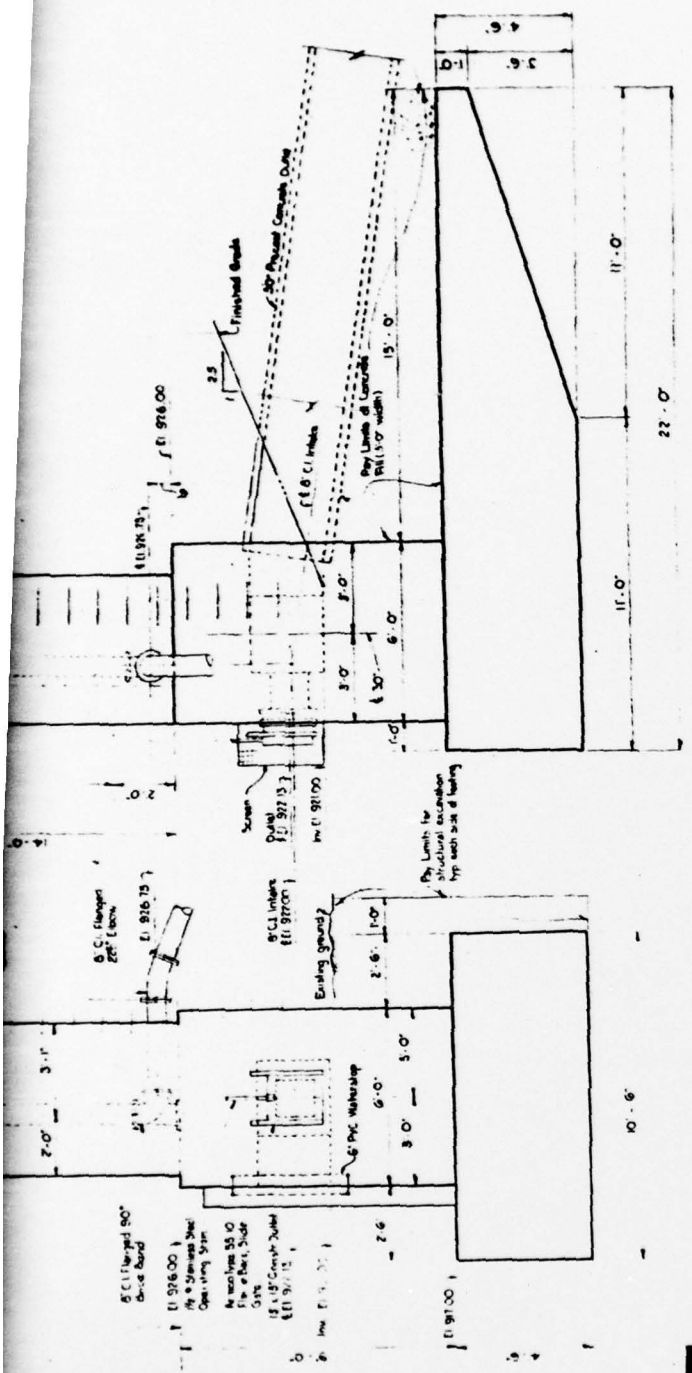
SPILLWAY & FOREBAY PROFILE

SCALE 1"=10'

2

SPILLWAY AND FOREBAY PROFILE HAMBURG RESERVOIR DAM	
NAT. ID NO.PA.00718	BERKS COUNTY
DATA OBTAINED FROM GLACE & GLACE CONSULTING ENGINEERS, PHILA.,PA. FILE CODE 5733, SHEET NO. 9 OF 20	
	PLATE 6


Armco HPB-24 Pedestals
Bronze Lifting Nuts
1½" ø Al. Railing
(Extra Heavy)
See Sht ø
for Railings Details
Steel ladder, see details
sheet No.12
Normal W.L.
El 952.00
Screen
Finished Grade
50' Precast Concrete Outlet



INTAKE TOWER SIDE ELEVATION
Scale: 3/8" = 1'-0"

INTAKE TOWER FRONT ELEVATION
Scale: 3/8" = 1'-0"

2

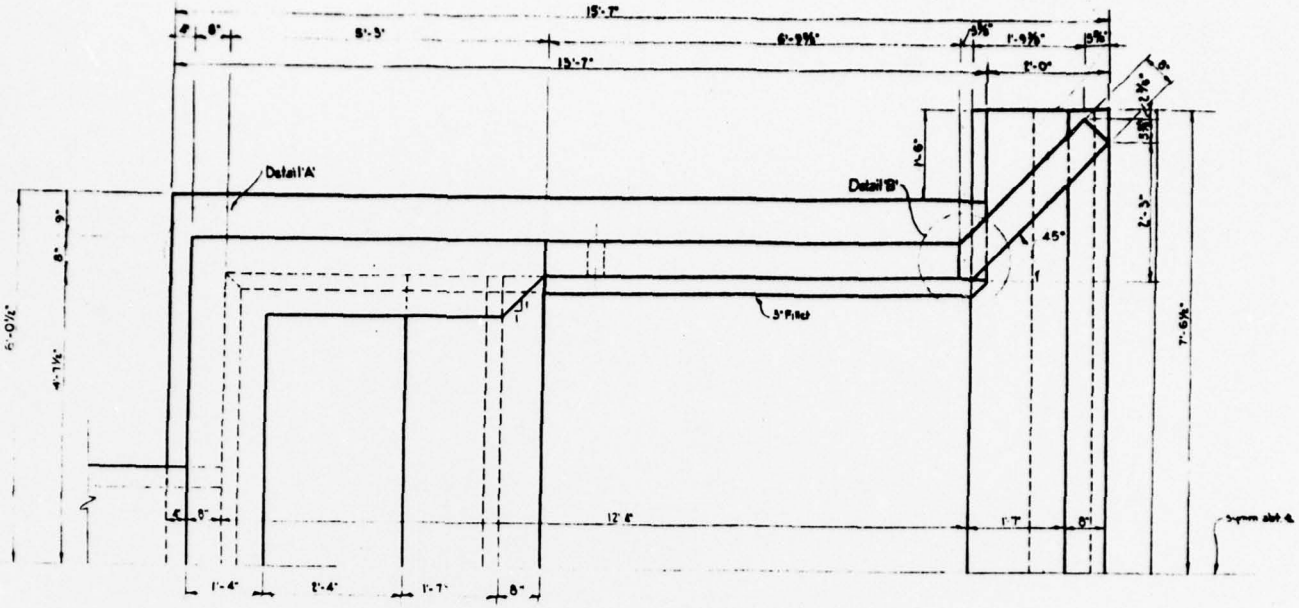
INTAKE TOWER DETAILS

HAMBURG RESERVOIR DAM

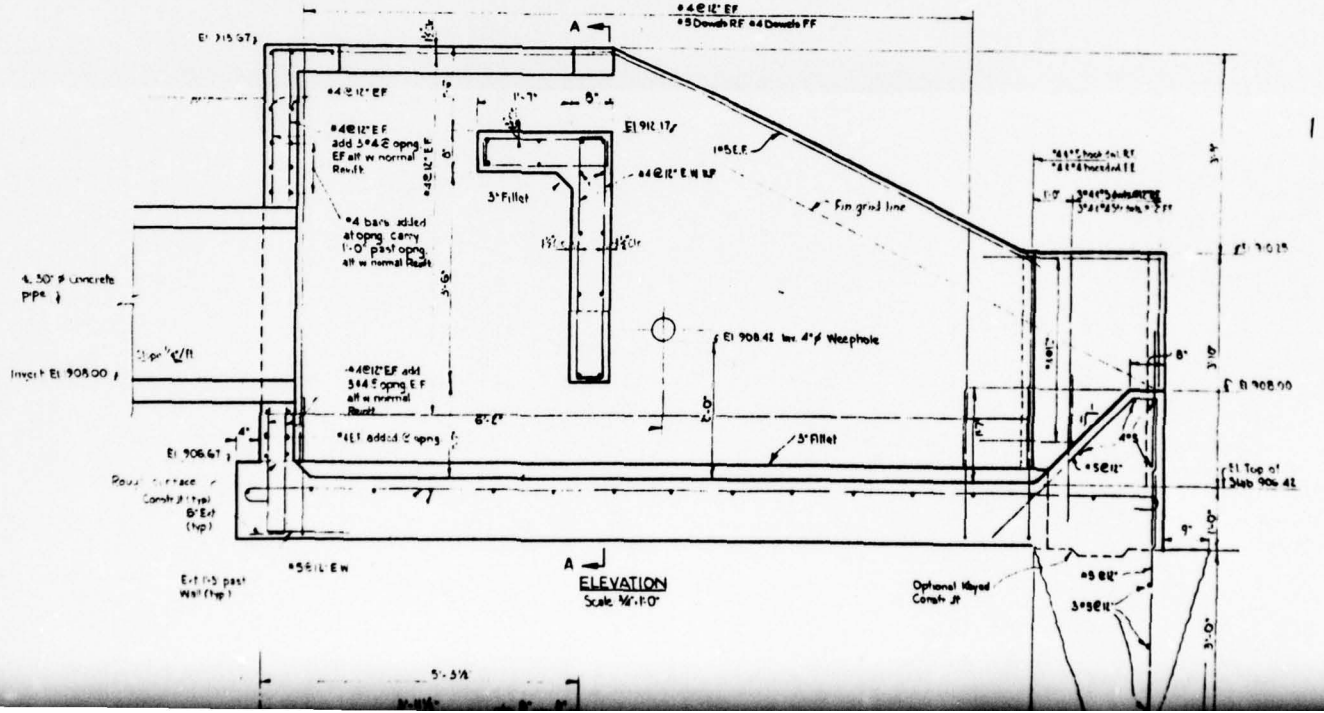
NAT. ID NO.PA.00718 BERKS COUNTY

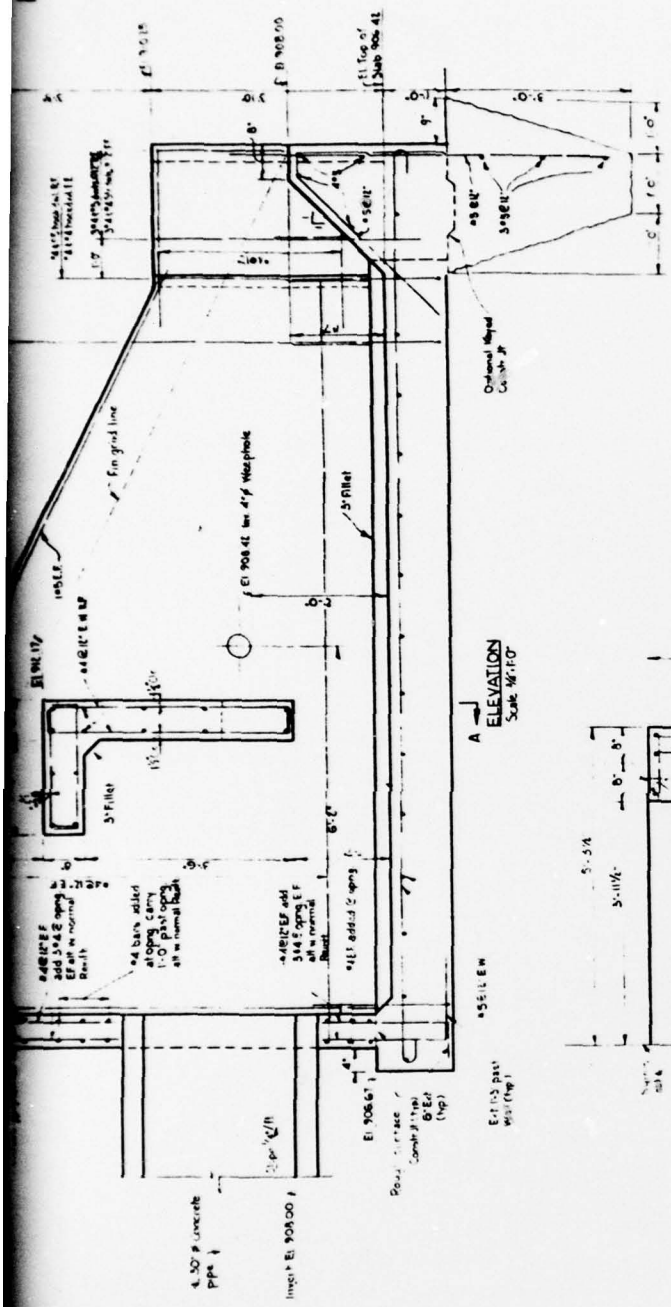
DATA OBTAINED FROM GLACE & GLACE CONSULTING ENGINEERS, PHILA.,PA. FILE CODE 5733, SHEET NO.10 OF 20

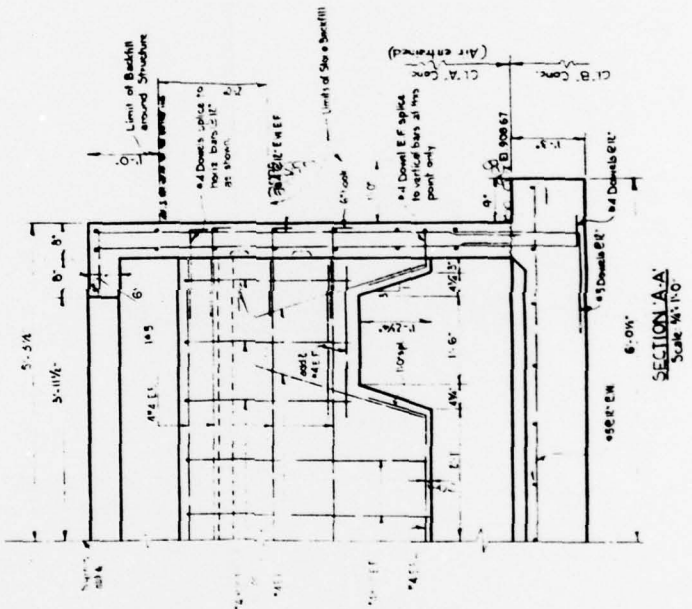
PLATE 7



HALF PLAN
Scale: ½"=1'-0"







2

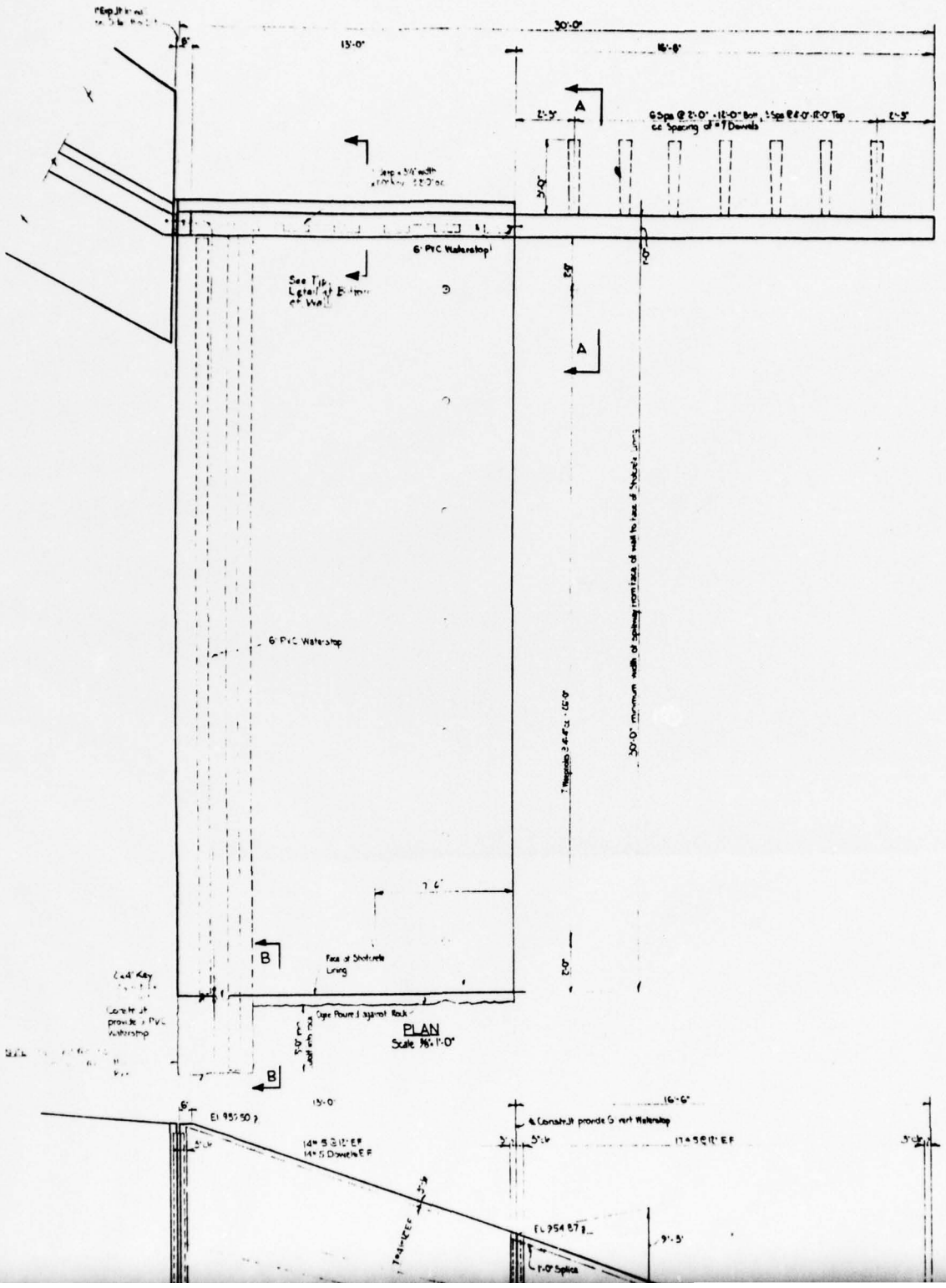
OUTLET STILLING BASIN DETAILS

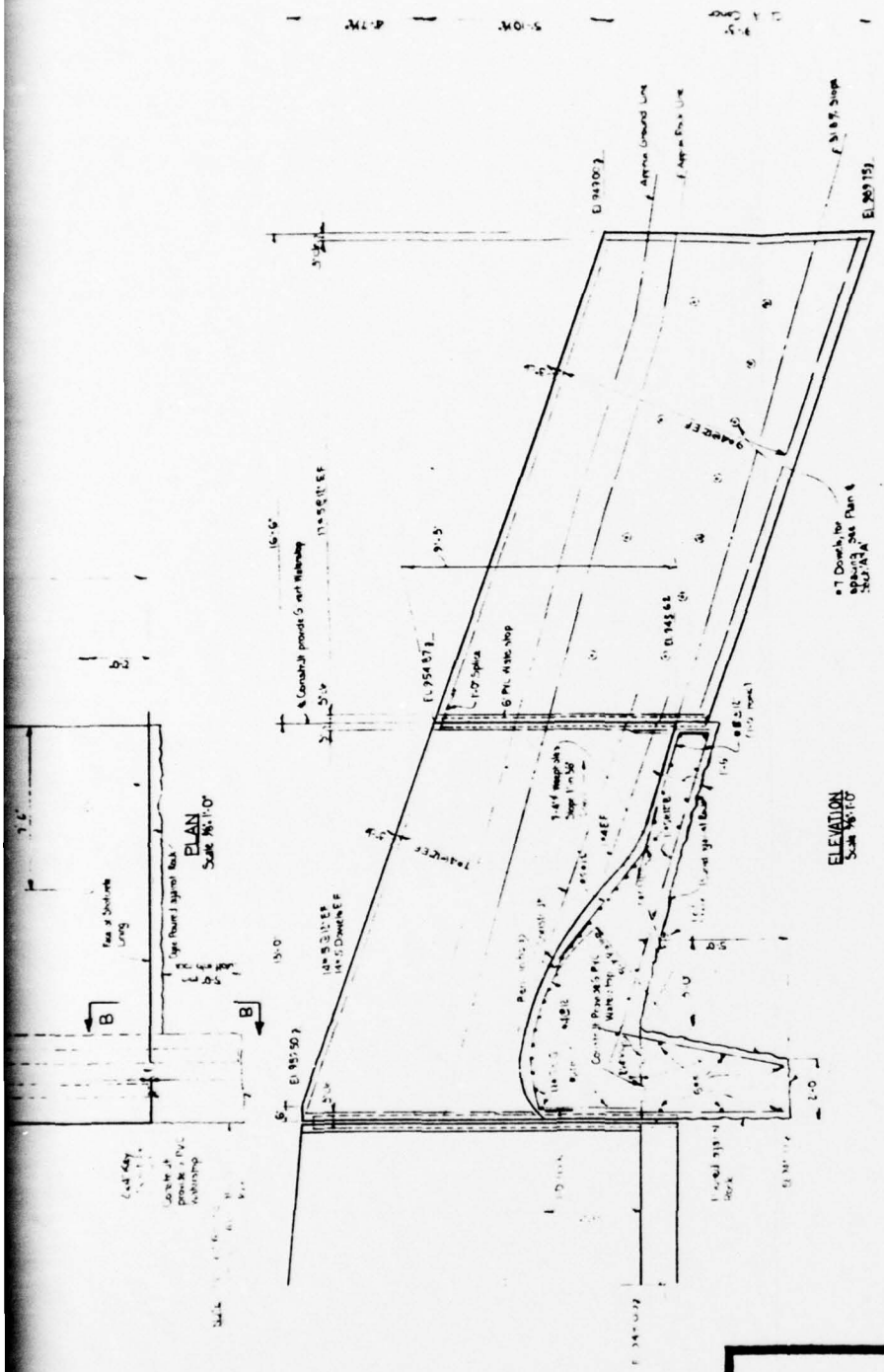
HAMBURG RESERVOIR DAM

NAT. ID NO.PA.00718 BERKS COUNTY

DATA OBTAINED FROM GLACE & GLACE CONSULTING ENGINEERS, PHILA.,PA. FILE CODE 5733, SHEET NO.13 OF 20

PLATE 8


30'-0"
15'-0"
16'-6"
A
6 Pvc Waterstop
6" PVC Waterstop
B
Face of Shotcrete Lining
PLAN
Scale 3/16"=1'-0"
15'-0"
16'-6"
EL 955.50 ?
EL 954.87 ?
1'-0" Splice

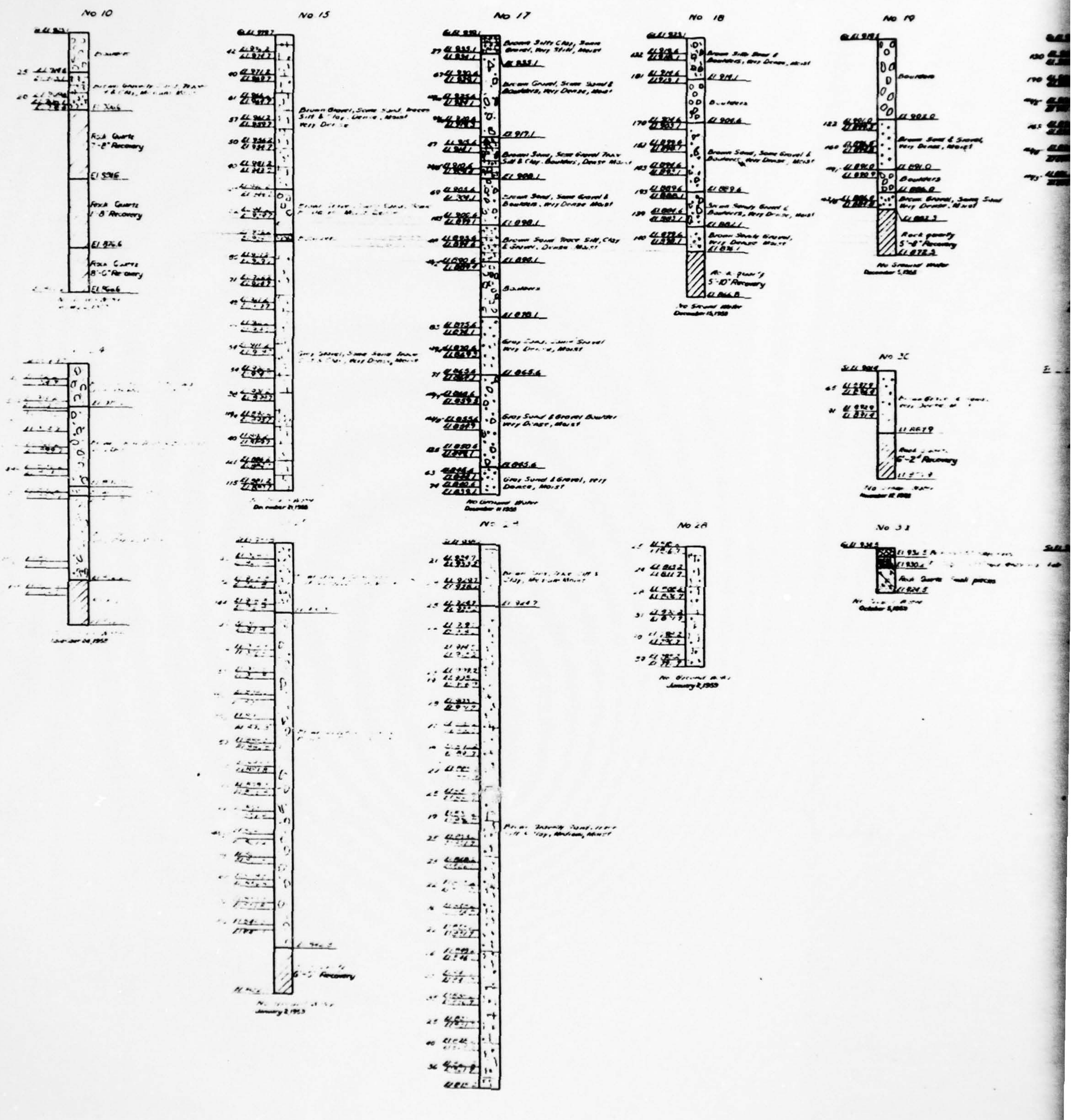


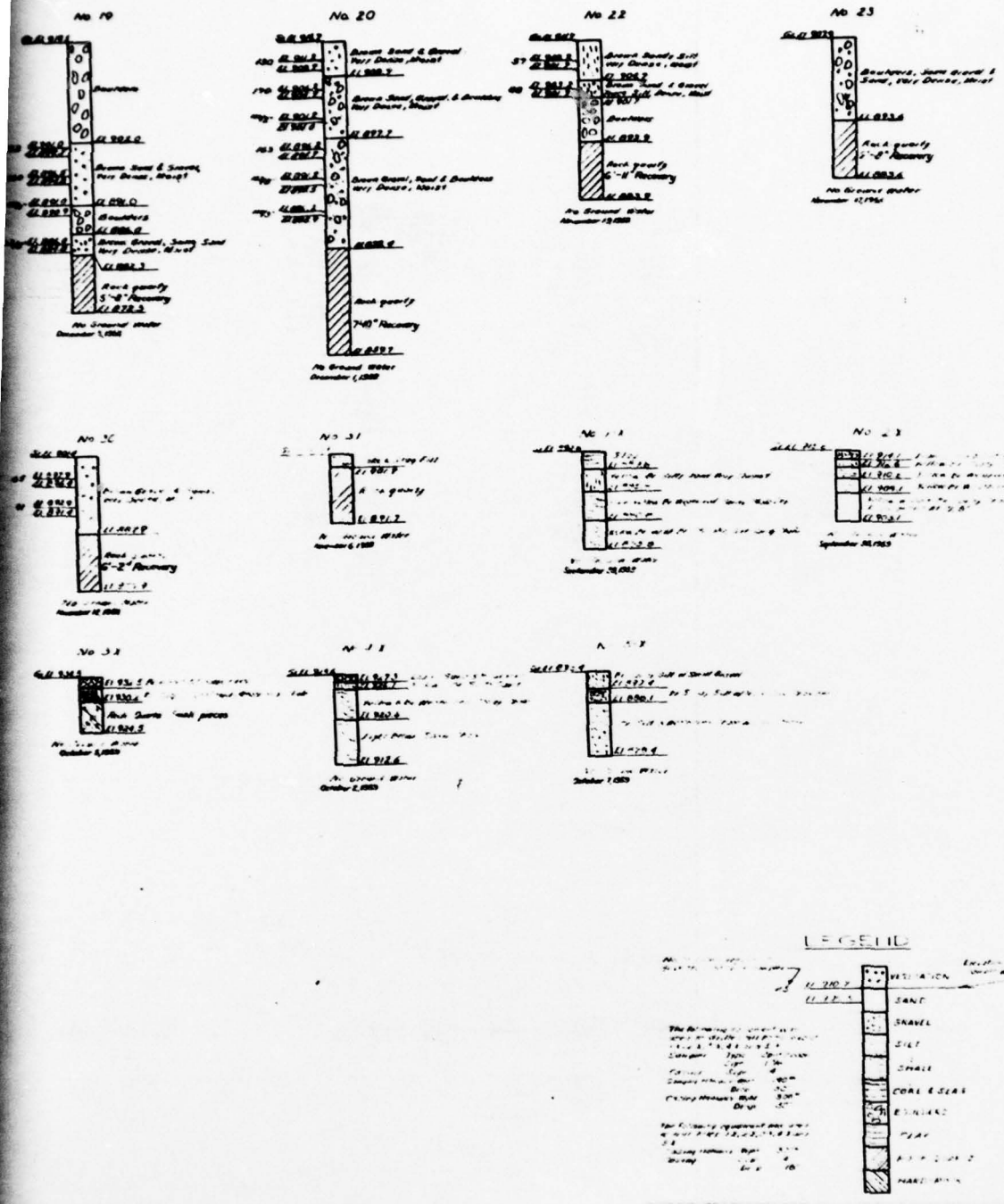
SPILLWAY WEIR DETAILS
HAMBURG RESERVOIR DAM

NAT. ID NO.PA.00718 BERKS COUNTY

DATA OBTAINED FROM GLACE & GLACE CONSULTING ENGINEERS, PHILA.,PA. FILE CODE 5733, SHEET NO.15 OF 20

PLATE 9


No 10
Boulders
Rock Quartz
7'-8" Recovery
Rock Quartz
1'-8" Recovery
Rock Quartz
8'-0" Recovery
No 15
Brown Gravel, Some Sand, Trace Silt & Clay, Dense, Moist
Very Dense
Boulders
Gray Gravel, Some Sand, Trace Silt & Clay, Very Dense, Moist
December 11, 1952
No 17
Brown Silty Clay, Some Gravel, Very Stiff, Moist
El 933.1
Brown Gravel, Some Sand & Boulders, Very Dense, Moist
El 917.1
Brown Sand, Some Gravel, Trace Silt & Clay, Boulders, Dense, Moist
El 908.1
Brown Sand, Some Gravel & Boulders, Very Dense, Moist
El 898.1
Brown Sand Trace Silt, Clay & Gravel, Dense, Moist
El 890.1
Boulders
El 870.1
Gray Sand, Some Gravel, Very Dense, Moist
El 865.6
Gray Sand & Gravel, Boulder, Very Dense, Moist
El 845.6
Gray Sand & Gravel, Very Dense, Moist
No Ground Water
December 11, 1952
No 18
Brown Silty Sand & Boulders, Very Dense, Moist
El 914.1
Boulders
El 904.6
Brown Sand, Some Gravel & Boulders, Very Dense, Moist
El 889.6
Brown Sandy Gravel & Boulders, Very Dense, Moist
El 881.1
Brown Sandy Gravel, Very Dense, Moist
Rock Quartz
5'-10" Recovery
No Ground Water
December 13, 1952
No 19
Boulders
El 902.0
Brown Sand & Gravel, Very Dense, Moist
El 891.0
Boulders
El 886.0
Brown Gravel, Some Sand, Very Dense, Moist
El 882.3
Rock Quartz
5'-8" Recovery
El 872.3
No Ground Water
December 5, 1952
No 30
6'-2" Recovery
No Ground Water
December 12, 1952
No 24
6'-5" Recovery
January 2, 1953
No 28
No Ground Water
January 2, 1953
No 33
Rock Quartz Small pieces
October 5, 1953



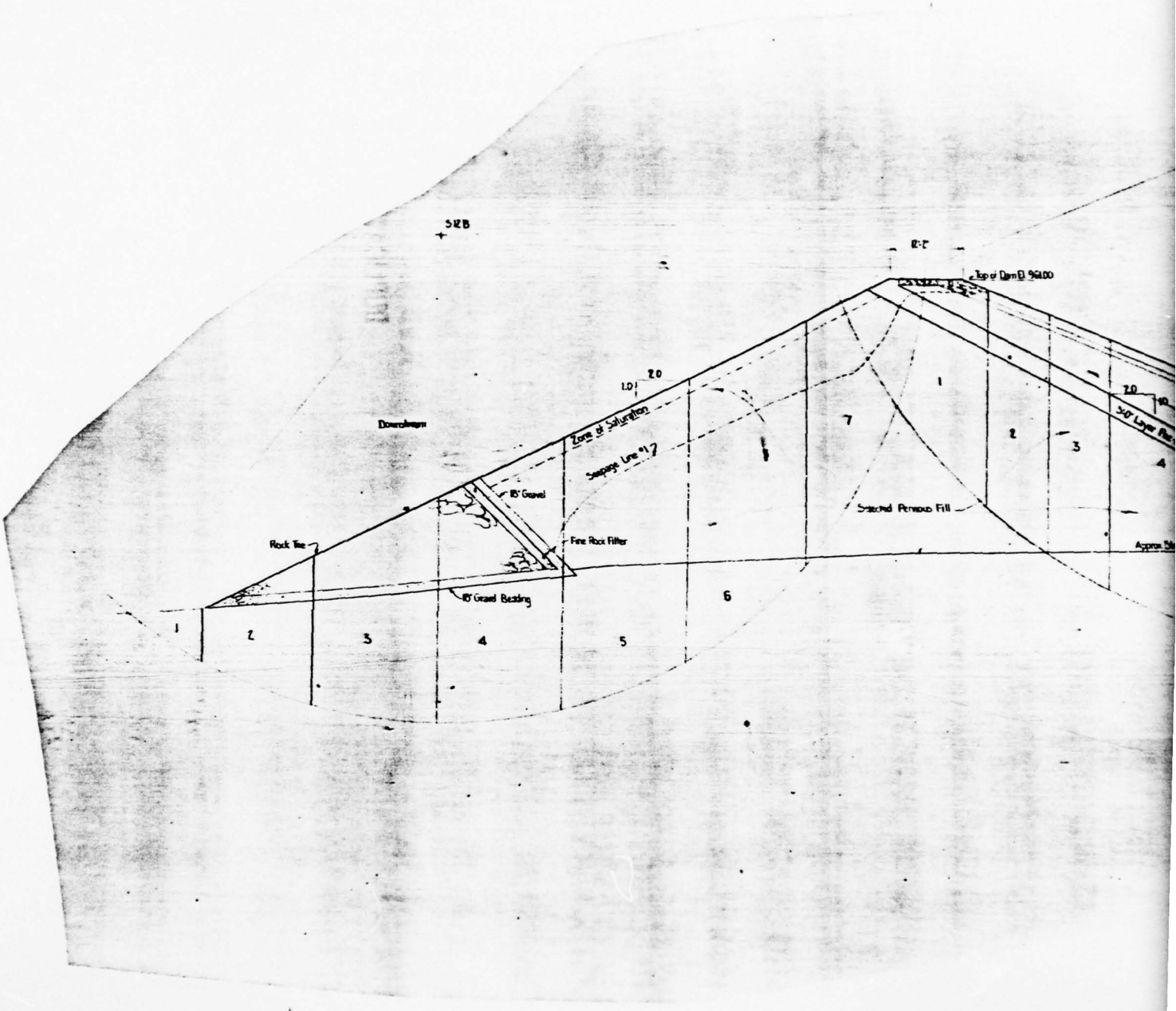
TYPICAL BORING LOGS

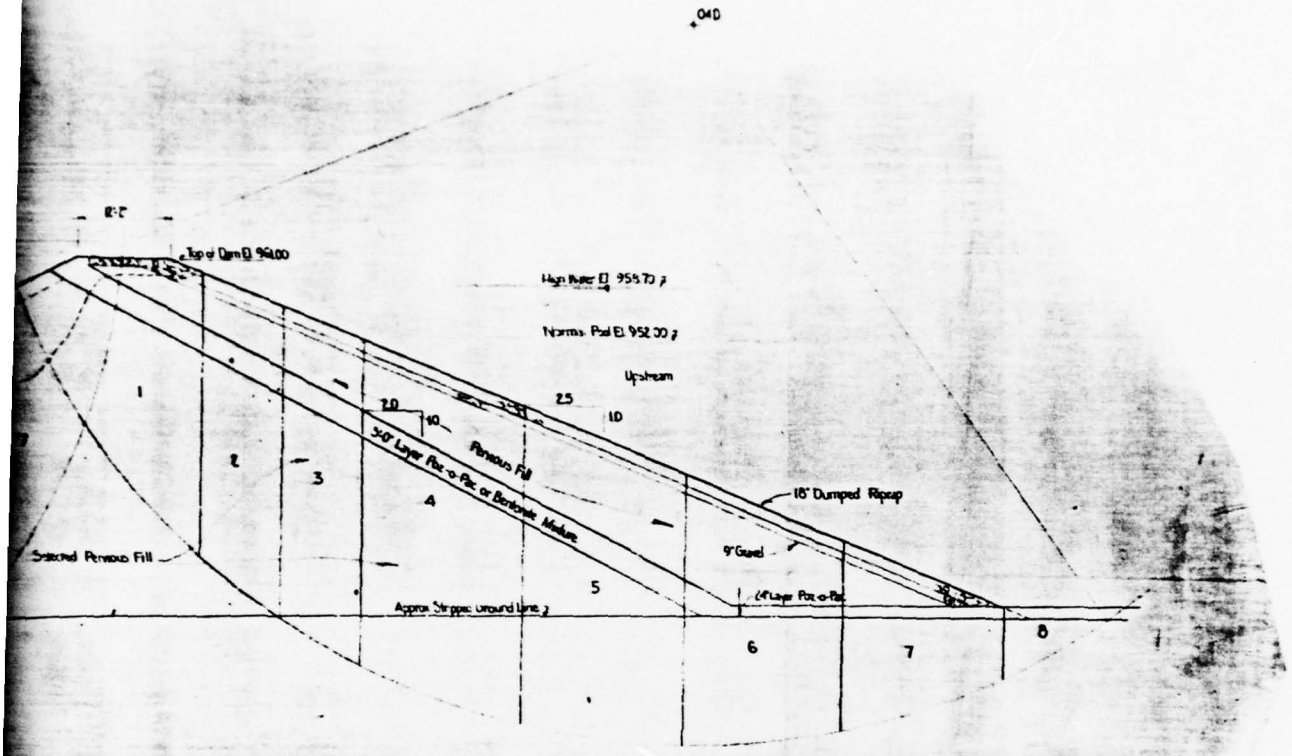
HAMBURG RESERVOIR DAM

NAT. ID NO.PA.00718 BERKS COUNTY

DATA OBTAINED FROM GLACE & GLACE CONSULTING ENGINEERS, PHILA.,PA. FILE CODE 5733, SHEET NO. 3 OF 20

PLATE 10


Top of Dam El 9400
2.0
1.0
Downstream
Zone of Saturation
Seepage Line #1
18" Gravel
Rock Toe
Fine Rock Filter
18" Gravel Bedding
Selected Pervious Fill
1
2
3
4
5
6
7



SUMMARY OF SLOPE STABILITY ANALYSIS

HAMBURG RESERVOIR DAM

NAT. ID NO.PA.00718 BERKS COUNTY

DATA OBTAINED FROM GLACE & GLACE CONSULTING ENGINEERS, PHILA.,PA. FILE CODE 5733, SHEET NO.1 OF 1

PLATE 11

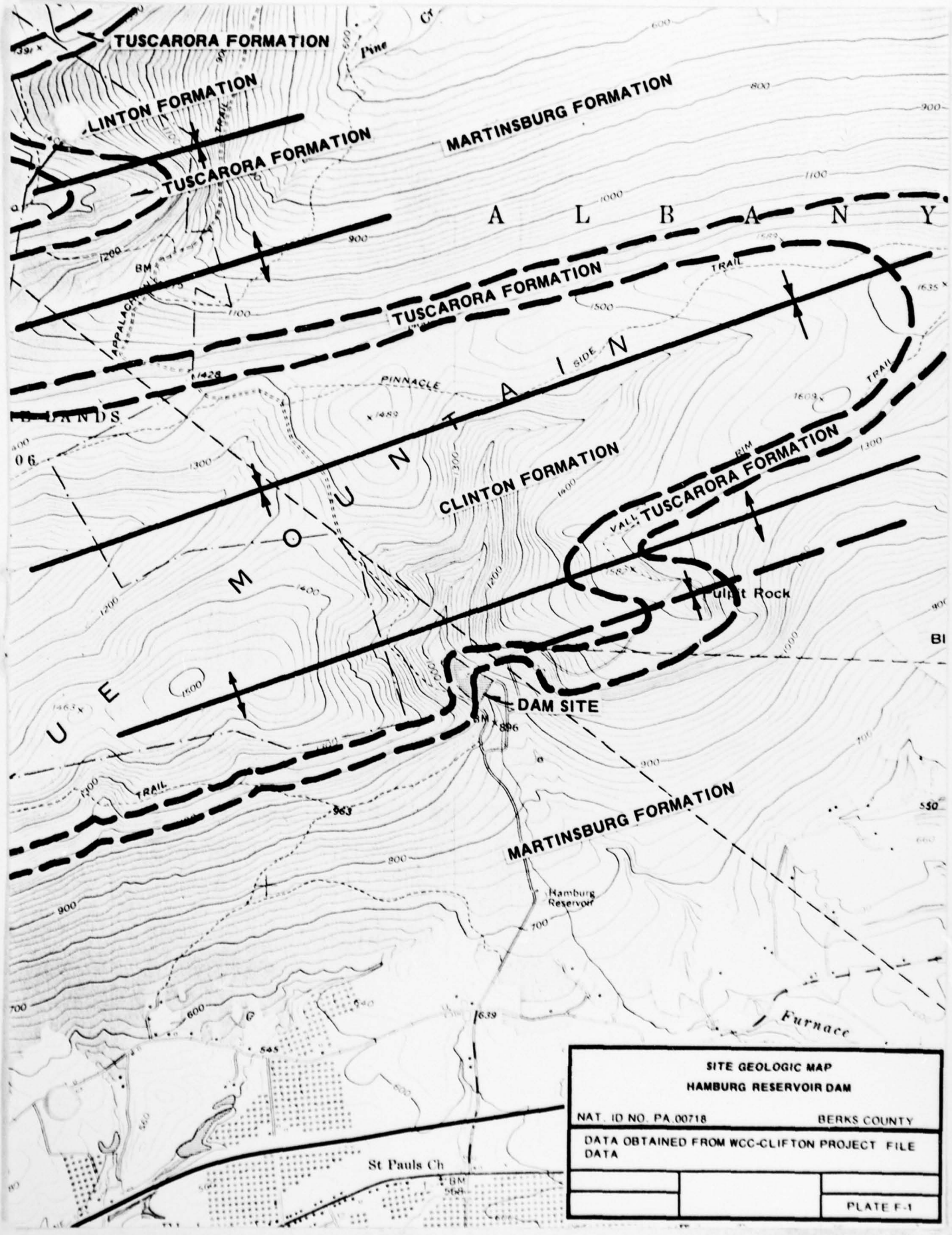
APPENDIX

F

SITE GEOLOGY
HAMBURG RESERVOIR

Hamburg Reservoir is located on the south side of Blue Mountain, at the border between the Great Valley section and the Appalachian Mountain section of the Valley and Ridge Physiographic Province. The bedrock beneath the dam is reported to consist of the shales of the Ordovician age Martinsburg Formation (see Plate F-1). To the northwest of the dam, underlying the reservoir, the Martinsburg Formation is bounded by the conglomerates and sandstones of the Silurian age Tuscarora and Clinton Formations. Bedding in the Martinsburg Formation is extremely deformed into a series of small scale tight asymmetrical folds with variable orientations, while in the overlying Tuscarora and Clinton Formations bedding is uniformly folded into a series of large scale folds trending N70°E, with the reservoir being located on the south limb of the southernmost syncline on Blue Mountain (dipping 50°NW). Two prominent sets of open joints have been reported in the Martinsburg Formation: the dominant set strikes N70°E and dips 60° to 70°SE; the lesser set strikes N10°W and dips nearly vertical. Joint spacing tends to be closely spaced at the dam site. The contact between the Ordovician and Silurian strata has been classically interpreted as an angular unconformity (Willard and Cleaves, 1939), although some workers feel the surface represents a fault contact (Alterman, 1971), and still others as a combination of angular unconformity with some associated minor fault movement (Stevens, 1969). This last view seems to best fit the evidence presently available. Since no major joint sets have been observed or reported to be associated with this fault, however, it should not be a cause for major concern.

As described in the application report of July 15, 1960, the configuration of the top of bedrock in the immediate dam foundation area is highly variable and was not encountered in the investigory drill holes in the east abutment vicinity. This condition was interpreted to represent an ancient stream valley that has been subsequently infilled with landslide materials. In spite of the relatively impervious nature of the Martinsburg shale and that major rock jointing strikes near parallel to the dam axis, conditions favoring downstream seepage do exist, namely the excessive overburden materials and corresponding deep rock in the east abutment area.


TUSCARORA FORMATION
LINTON FORMATION
TUSCARORA FORMATION
MARTINSBURG FORMATION
A L B A N Y
TUSCARORA FORMATION
PINNACLE
CLINTON FORMATION
TUSCARORA FORMATION
Pulpit Rock
DAM SITE
MARTINSBURG FORMATION
Hamburg Reservoir
Furnace
St Pauls Ch
SITE GEOLOGIC MAP
HAMBURG RESERVOIR DAM
NAT. ID NO. PA 00718
BERKS COUNTY
DATA OBTAINED FROM WCC-CLIFTON PROJECT FILE DATA
PLATE F-1